HOUSTON REGION
ITS STRATEGIC PLAN

prepared for

Houston-Galveston Area Council

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PBSJ

Battelle

DISCLAIMER

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City of Pasadena
City of Houston
City of Galveston
City of Missouri City
City of Texas City
City of Baytown
Smaller Cities
Brazoria County
Chambers County
Fort Bend County
Galveston County
Harris County
Liberty County
Montgomery County
Waller County
Air Quality
Comprehensive Planning
Environmental/Planning
Toll Roads
Private Business
H-GAC
METRO
TxDOT Beaumont District
TxDOT Houston District
TNRCC
Rural Transit
Environmental Interests
Intermodal Interests - Airports
Intermodal Interests - Bicycle & Pedestrian
Intermodal Interests - Ports
Intermodal Interests - Toll Roads
Neighborhoods/Other Citizen Interests
Other Modes, State Agencies, or Transportation Related Interests

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EXECUTIVE SUMMARY

Background

Intelligent Transportation Systems (ITS) include the application of advanced technologies like communications mechanisms, sensor technologies and other techniques to enhance the current transportation system and provide safer, efficient, and economic travel in the Houston region. The Houston region ITS Strategic Plan addresses and guides the region's transportation stakeholders to plan, program, and implement key ITS strategies based on the region's addressed needs and issues.

The Houston region is comprised of eight counties including Brazoria, Chambers, Fort Bend, Galveston, Harris, Liberty, Montgomery, and Waller counties (Figure ES-1). The Houston Region has been active for many years in deploying and operating ITS based systems.

Figure ES-1: Counties Included in the Houston Region ITS Strategic Plan (Identified with a ★)

As part of the plan, a regional system architecture was developed aimed at ensuring that the region's needs are consistent and translated into National ITS Architecture terminology and products. The architecture is described in a separate document and builds upon the defined TranStar architecture and enhances it to add additional systems and services that are applicable to the entire region.

This plan builds upon the system architecture and addresses the key question of "What next?". It defines a long-term vision for the region and identifies some key strategies that the region can implement to address critical technical and institutional needs. This plan will also address the planning, deployment and management of transportation facilities in the region and issues related to developing and implementing a regional ITS strategy. The plan will provide insight into the efficiency and sustainability of ITS applications to meet current and future challenges pertinent to service demands and economic constraints.

Key elements of the Houston region ITS Strategic Plan include:

Mission and Vision Statements

The ITS Strategic Plan for the Houston Region defines a "mission" statement:

"to enhance transportation services for the eight-county region by effectively and efficiently deploying advanced technologies and techniques for:

- Travel and traffic management
- Public transportation management
- Traveler information systems
- Travel payment
- Commercial vehicle operations
- Railroad at-grade crossings
- Emergency and incident management
- Advanced vehicle safety systems".

The Vision statements are non-technical and presented in an easily understood format and written from the viewpoints of various users of the system, including:

- Commuter
- Transit Rider
- Tourist
- Traffic Engineer

Legacy Systems

A detailed description of the existing and programmed Intelligent Transportation System (ITS) deployments in the Houston region is also presented as part of the Houston region ITS Strategic Plan. Systems addressed include advanced application areas of Traffic Management Systems, Traveler Information Systems, Transit Management and others. Detailed information on the existing and planned systems in the region includes:

- Functional features
- Operational characteristics
- Institutional/organizational issues
- Communication and coordination
- Extent of operations
- System status

Table ES-1 summarizes the legacy systems categorized by the application area, main system and subsystems, and its current status (existing/planned).

Table ES-1: Overview of Legacy Systems in the Houston Region

Application Area	System	Subsystem	Status
Traffic Management	Transportation/ Traffic Management Center	TranStar	Existing
	Detection and Surveillance Technologies	CCTV	Existing
		Loop Detectors	Existing
		Automatic Vehicle Identification (AVI)	Existing
		Video Imaging and Vehicle Detection Systems (VIVIDS)	Existing
		Flood and Weather Warning Systems	Existing
	Control Strategies	High Occupancy Vehicle (HOV) Lanes	Existing
		Ramp Metering	Existing
		Dynamic Message Signs (DMS)	Existing
		Signal Network	Existing
		Changeable Lane Assignment Signs (CLAS)	Existing
		Lane Control Signals	Existing
		Motorist Assistance Patrol (MAP) Program	Existing
		Emergency Vehicle Preemption	Existing
Traveler Information	Pre-trip and En-route Planning	TranStar Web Page	Existing
		Texas Travel Information System	Existing
		METRO Line	Existing
Electronic Payment	Electronic Toll Collection	EZ Pass Toll Program	Existing
	QuickRide Program	Carpool Program operated by METRO	Existing
Transit Management	Advanced Radio Communication System	Onboard System	Existing
		Communication Center Subsystem	Existing
		Communication Subsystem	Existing
	Computerized Telephone Information System (CTIS)	Interactive Voice Response System	Existing
		Personalized Bus Itinerary Service	Existing
	Integrated Vehicle Operation Management System (IVOMS)	Variety of Advanced Transit Applications	Planned
	METROLift	Personal Public Transit Service offered to persons with disabilities	Existing

Table ES-1: Overview of Legacy Systems in the Houston Region (Continued)

Application Area	System	Subsystem	Status
Emergency Management	City of Houston Emergency Management Division	Provides Emergency Services to 29 Cities in Harris County	Existing
	Harris County Office of Emergency Management	Provides emergency services before, during, and after natural or manmade disasters	Existing
Commercial Vehicle Operations	Truck Rollover Warning System (TRWS)	Vehicle Classification, Speed Detection and Warning Mechanisms	Existing
	Commercial Vehicle Travel Advisory System (CVTAS)	Dynamic Message Signs (DMS)	Existing
		Highway Advisory Radio (HAR)	Existing
Data Warehouse	Centralized Data Collection System	Not Applicable	Planned
Communications	Fiber Optic Communication Network	Not Applicable	Existing
	Cellular Digital Packet Data (CDPD)	Not Applicable	Existing
	Harris County Radio System (HCRS)	Not Applicable	Existing

Critical Requirements

The Houston region ITS Strategic Plan also addresses critical user needs, problems, and issues that relate to the development, deployment, and operations of ITS implementations in the region. Requirements gathered through interviews and discussion with the stakeholders provided the foundation to identify user needs and determine pertinent services desired. The interviews, workshops and focus group discussions helped create a requirements matrix, which contained information on the need, the associated stakeholders and the priority. This matrix was then compiled and sorted by priority. These needs reflect the perceptions of the stakeholders involved. Most of the needs in the region were identified as high and medium priority. This process is described in detail in the regional architecture document. A recap of the needs based on the application area is provided in Table ES-2 below.

Table ES-2: Critical Requirements

Functional/Application Area	Critical Need
Traffic Management	• Alleviating Congestion • Improve Capacity • Enhance Incident Management • Optimize Signal Control • Implement Arterial Management • Demand Management • Highway Rail Intersection Management • Interagency Coordination and Expansion
Traveler Information	• Better Content and Delivery of Traveler Information through a variety of dissemination techniques
Public Transportation	• Improve Mobility and Access • Develop Public Transit Management Strategies • Implement Advanced Transit Vehicle Systems • Improve Transit Traveler Information
Emergency Management	• Enhance Interagency Coordination • Improve Traffic Coordination • Faster Emergency Notification • Expand Flood Monitoring
Electronic Payment	• Expansion of Current Toll System • Multi-Modal Integration • Improve Toll Plaza Monitoring and Enforcement • Electronic Passenger Fare Collection
Commercial Vehicle Management	• Improve Safety • Improve Commercial Vehicle Management
Vehicle Safety	• Research on lateral and longitudinal collision systems and truck rollover collision systems
Emissions Management	• Improve sensor testing and operational policies for emissions management and testing
Archived Data Management	• Expansion of current data warehousing efforts
Safety and Security	• Safety of Rail-road Intersections • Safety for Pedestrians and Bicyclists • Applications for Homeland Security
Maintenance & Construction	• Smart Work Zone Strategies
Other	• Improve Agency Coordination • Develop strategies for Public Involvement and Education

Themes, Trends, and Strategies

The Houston region ITS Strategic Plan addresses issues with respect to development, deployment, and operation of advanced systems that exist and planned for the future. A variety of topics are addressed as part of the plan, which aim to provide some insight and direction to assist agencies in maximizing the benefits of ITS technology. Topics include methodologies required to accomplish the vision, goals and objectives and guiding principals that need to be incorporated into existing agency policies and procedures to facilitate operations and management of the integrated Houston ITS system. Key topics addressed include:

- Integration and Information Sharing
- ITS Standards
- System Redundancy and Survivability
- System Expandability and Migration
- Public and Private Partnership
- Leveraging Funds for Homeland Security
- Finance
- Public Awareness and Involvement
- Maintenance
- Staff Resources and Training
- Performance Measures

Roles and Responsibilities

The Houston Region ITS Strategic Plan provides suggested deployment guidelines, including generalized agency roles and responsibilities, to support the development of ITS. This section is meant to provide suggestions, not prescriptive requirements. The most important component of successful area-wide ITS deployment is the active and continuous cooperation between transportation stakeholders. Critical actions addressed include:

- Appropriate components of the Houston Region ITS Strategic Plan should be incorporated into the regional transportation planning process and the Regional Transportation Plan.
- All significant transportation management and information system deployment efforts should be carried out in a cooperative manner within the metropolitan area with projects being proposed, promoted, and deployed with due consideration for the integration objectives of the metropolitan area.
- Consideration should be given to the potential rural applications of major system deployments in the more urban areas of the metropolitan area to maximize any economies of scale possible throughout the area.

Potential Projects/Strategies by Application Area

The Houston region has implemented a wide variety of ITS projects and is reaping the benefits of the deployments. The ITS Strategic Plan recommends additional high-level deployment concepts based on the requirements analysis and the Regional ITS Architecture. The projects recommended have been categorized based on the functional/application area they fall under. Each of the projects described contain information on the description, needs, architecture elements (market packages), potential impacts, and an approximation on costs.

Table ES-3: Potential Projects Listed by Functional/Application Area

Functional/Application Area	Recommended Projects
Traffic Management	Project # 1: Expansion of Surveillance to Arterial Streets Project # 2: Expansion of CCTV and sensor systems on freeways and critical areas Project # 3: Expansion of the RCTSS system Project # 4: Arterial street traffic detectors for the RCTSS Project # 5: Expansion of Incident Management off freeways Project # 6: Deploy and Integrate with other agencies detecting Flood Conditions Project # 7: Expansion of Air Quality and Emissions Monitoring Project # 8: Establish Data Sharing Agreements and Formats Project # 9: Automate HOV Operations
Traveler Information	Project # 1: Deploy and Promote 511 traveler information system Project # 2: Marketing effort for Traveler Information
Public Transportation	Project # 1: Enhance Transit Traveler Information with real-time data
Emergency Management	Project # 1: Enhance Emergency Management Operations and Coordination
Electronic Payment	Project # 1: Regional Integrated Transportation Smart Card (Transit, Tolls, Parking, etc)
Commercial Vehicle Operations (CVO)	Project # 1: HAZMAT Identification
Maintenance & Construction	Project # 1: Smart Work Zones
Other	Project # 1: Enhance Agency to Agency Outreach, Coordination/Communication

Phasing of Projects

The Houston region ITS Strategic Plan also provides a deployment-phasing table of the recommended projects identified in the earlier section. The timing of project implementation will ultimately depend on the availability of funding and agency support. The high-level phasing plan presented here is based on the approximate relative priority and urgency of the needs addressed by the various projects (most needs were identified as high or medium priority), and on consideration of project inter-dependencies. Table ES-4 categorizes each project into one of four phases, reflecting the timing of their initiation: immediate (e.g., next two years), near-term (years 3 to 5), and long-term (year 6 and beyond). Not all projects will be completed within the time frame that they are initiated, including large, complicated projects, as well as on-going efforts, e.g., agency coordination.

Table ES-4: High-Level Project Phasing Plan

Project	Recommended Phasing		
	Immediate (1-2 Yrs)	Near-Term (3-5 Yrs)	Long-Term (Yr 6+)
Traffic Management			
#1 – Expansion of Surveillance to Arterial Streets	■	■	■
#2 – Expansion of CCTV and Sensor Systems on Freeways and Critical Areas	■	■	■
#3 – Expansion of the RCTSS System	■	■	■
#4 – Arterial Street Traffic Detectors for the RCTSS	■	■	■
#5 – Expansion of Incident Management Off Freeways		■	■
#6 – Deploy and Integrate with Other Agencies Detecting Flood Conditions		■	■
#7 – Expansion of Air Quality and Emissions Monitoring		■	■
#8 – Establish Data Sharing Agreements and Formats	■	■	
#9 – Automate HOV Operations		■	
Traveler Information			
#1 – Deploy and Promote 511 Traveler Information System	■	■	
#2 – Marketing Effort for Traveler Information	■	■	■
Public Transportation			
#1 – Enhance Transit Traveler Information with Real-Time Data		■	
Emergency Management			
#1 – Enhance Emergency Management Operations and Coordination	■	■	
Electronic Payment			
#1 – Regional Integrated Transportation Smart Card		■	■
Commercial Vehicle Operations			
#1 – HAZMAT Identification		■	■
Maintenance and Construction			
#1 – Smart Work Zones	■	■	
Other			
#1 – Enhance Agency-Agency Outreach, Coordination/Communication	■	■	■

1.0 INTRODUCTION

Intelligent Transportation Systems (ITS) include the application of advanced technologies like communications mechanisms, sensor technologies and other techniques to enhance the current transportation system and provide safer, efficient, and economic travel in the Houston region.

The Houston region ITS Strategic Plan is intended to address and guide the region's transportation stakeholders to plan, program, and implement key ITS strategies based on the region's addressed needs and issues. A previous document, titled "Houston Region System Architecture" focused on identifying a "framework" of how ITS systems are expected to be implemented in the region. The system architecture report detailed the systems and agencies that need to interact and share data to provide for safer travel in the region. This plan builds upon the system architecture and addresses the key question of "What next?". It defines a long-term vision for the region and identifies some key strategies that the region can implement to address critical technical and institutional needs.

The purpose of this plan is also to address the planning, deployment and management of transportation facilities in the region. The plan will aim to address issues in developing and implementing a regional ITS strategy to enhance operational, management, monetary, and end-user benefits through improvements in resource utilization, safety, mobility, accessibility and productivity of the system. The plan will also provide insight into the efficiency and sustainability of ITS applications to meet current and future challenges pertinent to service demands and economic constraints.

1.1 Document Organization

Chapter 2 details the mission and the long-term vision for the Houston region ITS Strategic Plan.

Chapter 3 documents the legacy systems in the Houston region and identifies these systems based on the program/application areas they fall under, i.e. traffic management, emergency management, etc.

Chapter 4 identifies and describes critical user needs and issues (both technical and institutional) that relate to the development, deployment, and operations of ITS implementations in the region.

Chapter 5 provides the themes, trends, and strategies required for the region to successfully deploy ITS systems. Themes identify and underscore the various underlying processes and activities that are vital during the development and implementation of a regional ITS system. Trends symbolize recurring themes as observed during the development of the requirements model based upon user input on system needs, issues, and problems. Strategies reflect upon the approach agencies should pursue to counter user needs, problems, and issues through selection of ITS user services and tools to maximize safety and efficiency of the transportation system.

Chapter 6 identifies and describes the roles and responsibilities of the current and future stakeholders in the Houston region.

Chapter 7 describes the high-level deployment concepts based on the user needs and the region's system architecture. It also lists a prioritization matrix of the proposed deployment projects.

Chapter 8 summarizes the Strategic Plan.

2.0 ITS MISSION AND VISION

2.1 ITS Mission

The mission is to enhance transportation services for the eight-county region by effectively and efficiently deploying advanced technologies and techniques for:

- Travel and traffic management
- Public transportation management
- Traveler information systems
- Travel payment
- Commercial vehicle operations
- Railroad at-grade crossings
- Emergency and incident management
- Advanced vehicle safety systems

2.2 ITS Vision

What the Vision IS – The Houston region ITS Strategic Plan Vision is a non-technical, **long-term view** of how life will be with the implementation of the regional ITS Plan.

What the Vision IS NOT – The vision is **not** what we expect to achieve in the near term, but it is a goal in the future toward which we strive.

The Vision is written from the viewpoints of various users of the system, including:

- Commuter
- Transit Rider
- Tourist
- Traffic Engineer

The ITS vision is a useful tool to convey the types of experiences various users could anticipate in a non-technical and easily understood format.

2.2.1 An ITS Vision for the Commuter

Before leaving home, the commuter electronically checks a personalized traffic report, which is automatically provided to him. The report indicates that traffic is flowing smoothly, and the commuter heads for work on the preferred route. Tolls are automatically calculated and debited from a prepaid, integrated regional transportation account. A list of available parking spaces appears on an in-vehicle screen, and on arrival, the parking fee is charged to the same account.

2.2.2 An ITS Vision for the Transit Rider

Returning to his office from a late afternoon meeting, the transit rider looks down on the deserted bus stop, through a sheet of rain, from his tenth floor office window. He knows the 2 Bellaire bus is usually right on time, but can run late during inclement weather, when traffic moves more slowly. Its two minutes after the time the bus normally arrives—has the bus already passed, should he try to catch a ride with a co-worker? He remembers that he can check the real-time location and status of his bus on the Internet. He finds that the bus is still several blocks away—just enough time to make it down to the stop. He jumps on the bus and finds a seat, his fare automatically charged to his electronic smart card in his pocket, sensed by electronic readers mounted in the doorway of the bus. Having dozed off, he's awakened by the announcement of his stop by a pleasant, clear, pre-recorded voice, the announcement generated automatically based on the vehicle's location.

2.2.3 An ITS Vision for the System Operator

A system operator at the TranStar Traffic Management Center is alerted to a traffic slowdown on a busy section of freeway. Video surveillance cameras reveal a minor traffic accident has occurred and a traffic advisory message is selected. This message is relayed through roadside displays, announcements, broadcast information, and private advisory services which can be accessed from homes, work places and public areas. The travelers can chose an alternative route, improving his/her travel time and alleviating congestion at the accident site.

2.2.4 An ITS Vision for the Tourist

A first-time Houston area visitor stops by the computerized regional travel information center at the Intercontinental Airport after picking up a rental car. The cost of the rental vehicle includes toll, parking, and other regional transportation charges. At the travel center, he enters the location of the hotel and other destinations and is provided a map of suggested routes and a list of other travel options tailored to the visitor's personal profile, including transit and shuttles. On the way to the hotel, the rental car's in-vehicle audio information system announces services available at each off-ramp. The tourist is not familiar with the area and dials 511 to determine what conditions are on the roadways. Upon hearing of a major incident on I-45, he decides to take the Hardy Tollway to his appointment downtown.

3.0 LEGACY SYSTEMS

This section provides an overview of the existing and programmed Intelligent Transportation System (ITS) deployments in the Houston region. These systems include Traffic Management Systems, Traveler Information Systems, Transit Management and others. The emphasis of the document is to identify systems and provide key information in the following areas:

- Functional features
- Operational characteristics
- Institutional/organizational issues
- Communication and coordination
- Extent of operations
- System status

3.1 Traffic Management

This section focuses on the available ITS resources supporting traffic management. Traffic management includes detection, data processing, response to incidents and emergencies, control of traffic signals, ramps, and Highway Occupancy Vehicle (HOV) facilities. This section discusses traffic management in three areas:

- Traffic Management Center
- Detection and Surveillance
- Control Strategies

3.1.1 Transportation/Traffic Management Center

Traffic Management Centers (TMC) typically serve as the focal point for traffic management service operations. They function as a central hub that receives, processes, and disseminates information, enabling swift response to any unexpected or emergency conditions and situations. Data from various field equipment is processed by staff, and then information is relayed to the public through various means such as radio, Dynamic Message Signs (DMS), internet, etc.

Figure 3-1 illustrates Traffic Management Center locations in Texas.

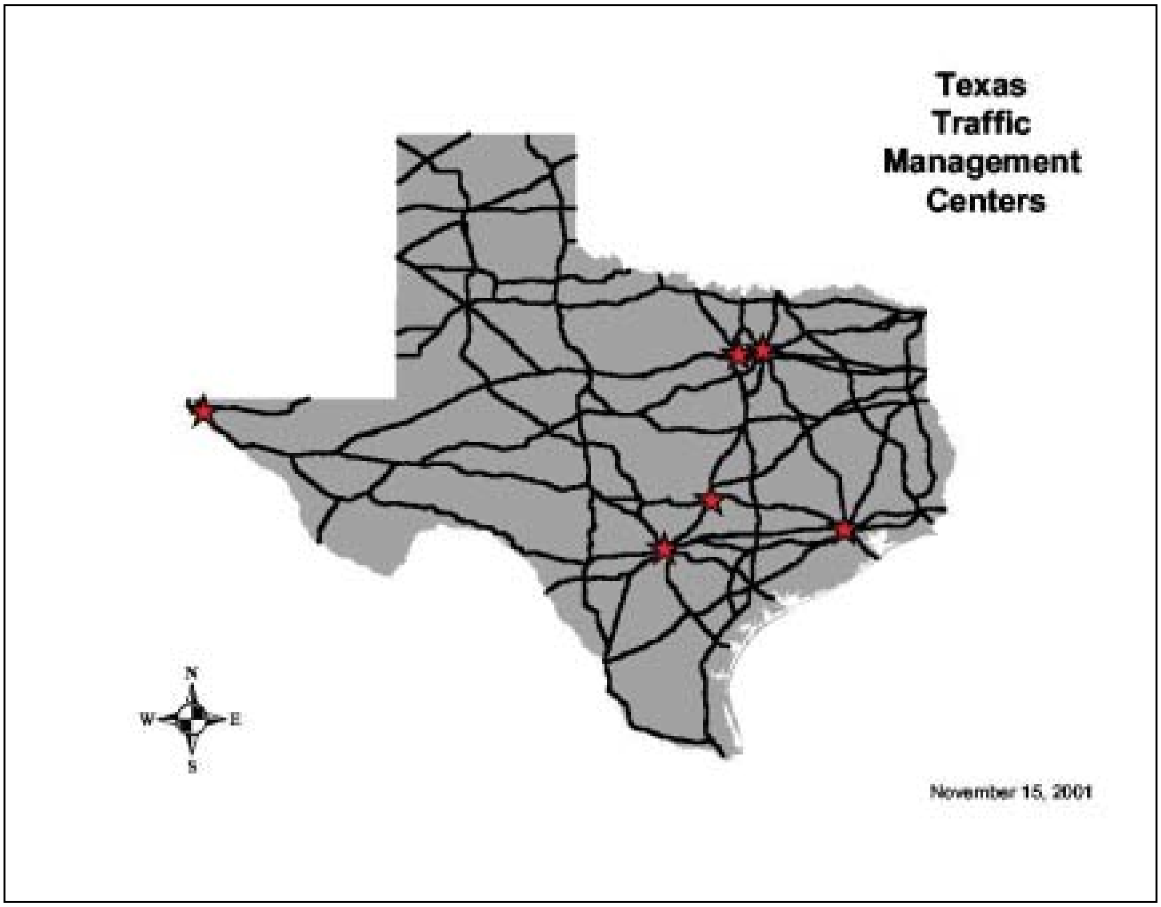

Figure 3-1: Existing TxDOT Traffic Management Centers

3.1.1.1 <u>Houston TranStar</u>. Houston TranStar provides traffic management, traveler information, emergency management, and transit management services within the Greater Houston area. The traffic management center is jointly operated by four agencies that include the Texas Department of Transportation (TxDOT), Metropolitan Transit Authority of Harris County (METRO), Harris County, and City of Houston. These agencies are responsible for operation and management services on freeways, arterial streets, high occupancy vehicle lanes, and the transit system. Operational and administrative activities of partner agencies within the facility include:

- TxDOT: Traffic operations and freeway traffic management, incident management, information dissemination, and Motorist Assistance Patrol (MAP) dispatch
- METRO: Police dispatch, bus dispatch, HOV enforcement, traffic engineering
- Harris County: Traffic engineering and signal systems, Office of Emergency Management, and MAP
- City of Houston: Police dispatch, signal systems, and Office of Emergency Management

TranStar's service area encompasses 5,436 square miles providing traffic operation and management services to a population of approximately 4.0 million. Agencies at TranStar jointly manage a number of programs including:

- Freeway management system, 160 centerline miles out of a projected 300 miles
- Freeway and arterial incident management
- Ramp metering at 128 ramps
- 316 closed circuit television cameras
- 154 dynamic message signs
- 94.4 miles of barrier separated reversible HOV lanes, with an additional 6.6 miles of diamond lanes on IH-10 freeway
- Regional computerized traffic signal system of 2800 planned signals
- Emergency management operations
- Motorist assistance patrol
- Heavy wrecker contract for commercial vehicle removal
- Flood alert systems/ Roadway weather information systems
- Highway advisory radio (12 fixed sites and 1 portable site)

TranStar also works in conjunction with the Houston-Galveston Area Council Houston (H-GAC), Houston Fire Department, and the port of Houston. In addition, four major television networks receive CCTV camera feeds which they use for news broadcasts.

The TranStar organization is structured such that operators within each agency report to agency specific on-site managers. The managers report to a TranStar Leadership Committee, who in turn reports to the TranStar Executive Committee. The TranStar Director facilitates interaction between the agencies.

3.1.2 Detection and Surveillance Technologies

Traffic management centers need accurate and timely data from roadway detection units and visual information on current traffic conditions in order to manage traffic and incidents, and also to disseminate information to travelers.

TranStar receives information and data from closed circuit television cameras (CCTV), roadway loop sensors, automatic vehicle identification (AVI) systems, video imaging detection systems (VIVIDS), and flood sensors. Real time data from the on-site equipment is first transferred to the communications hub and then to the TranStar control room.

3.1.2.1 Closed Circuit Television Cameras. Closed circuit television cameras (CCTV's) are used to identify and verify incidents on freeways. Currently 316 cameras are deployed at approximately one mile intervals at key locations including I-45 (North and Gulf Freeways), I-10 East and West freeways, Beltway 8, I-610 loop, US-290 (Northwest freeway), US-59 (Southwest Freeway), SH 288, and SH 225. The cameras can be rotated 355 degrees along the horizontal axis and 120 degrees vertically, which enables coverage of a larger view field. A zoom feature enables recognition of collision situations up to ½ mile distance. Most of the camera sites are located at cross streets, which enables traffic surveillance on freeways, feeder roads, and arterials.

All camera installations and operations are controlled by TxDOT. Additional camera installations are now under contract by TxDOT and other partner agencies. These contracts will enable expansion of the camera system.

3.1.2.2 Loop Detectors. Loop detectors are extensively used for collecting information on traffic volumes, speeds, and occupancy in each lane of the freeway. Currently, there are approximately 750-loop detector stations located on the Gulf, Katy, Northwest, and Southwest freeways with an additional 114 detectors on the HOV lanes. Table 3-1 illustrates the loop detector stations along different locations in Houston.

Table 3-1: Loop Detector Stations in Houston

Facility	Number of Loop Detector Stations
I-45 Gulf Freeway	205
I-45 North Freeway	127
I-10 Katy Freeway	189
US-59 Southwest Freeway	110
US-290 Northwest Freeway	119
I-45 Gulf HOV	23
I-45 North HOV	36
I-10 Katy HOV	29
US-59 SW HOV	23
Total	**894**

Figures 3-2, 3-3, and 3-4 illustrate closed circuit camera locations, trap (dual loops) detector locations, and non-trap (single loop) detector corridors, respectively, that are used for monitoring traffic flow and collecting traffic information on freeways respectively.

3.1.2.3 Automatic Vehicle Identification. Automatic vehicle identification (AVI) is used to collect real-time information on current travel conditions on freeways and HOV lanes. The main source of AVI data in Houston are vehicles using the “EZ Tag” automatic toll collection tags from the Harris County Toll Road Authority (HCTRA). AVI deployments include antennas and tag readers installed on structures along freeways and HOV lanes spaced at one to five mile intervals. The antennas and readers monitor the passage of probe vehicles that are equipped with transponder tags. The tags are powered by a small battery which enables them to reflect signals transmitted from the AVI antennas. The time, identification, and location stamp of the probes collected at the AVI reader station are transmitted to a central computer over a telephone line. Probe vehicle data from successive AVI readers are used to calculate average travel times and speeds for a roadway segment. The speed on a link is calculated using the time it takes a vehicle equipped with an AVI tag to travel the predetermined distance between the two AVI tag readers. Average vehicle speeds on various links are displayed in real-time on a speed map on the TranStar website and are also used for the route builder and speed tables on the website.

Currently AVI technology is being used to determine travel speeds on 227 miles of Houston area freeways and 74 miles of HOV lanes. AVI is also deployed on Hempstead Road, which parallels U.S. 290. AVI deployments include 232 AVI reader stations, 5 mobile readers and almost 700,000 AVI toll tags (transponders).

Figure 3-5 illustrates the locations of AVI data collection checkpoints.

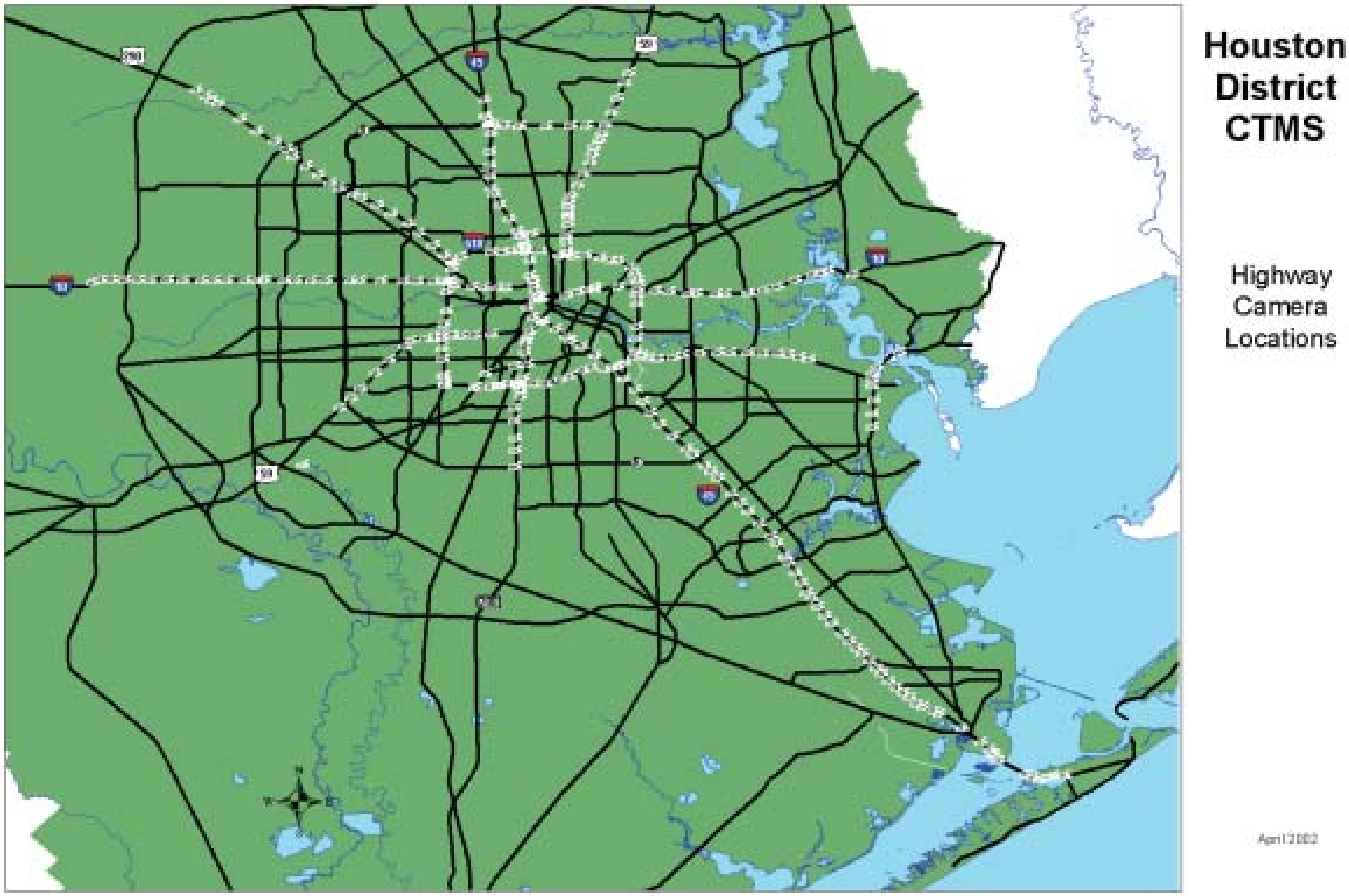

Figure 3-2: TxDOT Closed Circuit Camera Locations

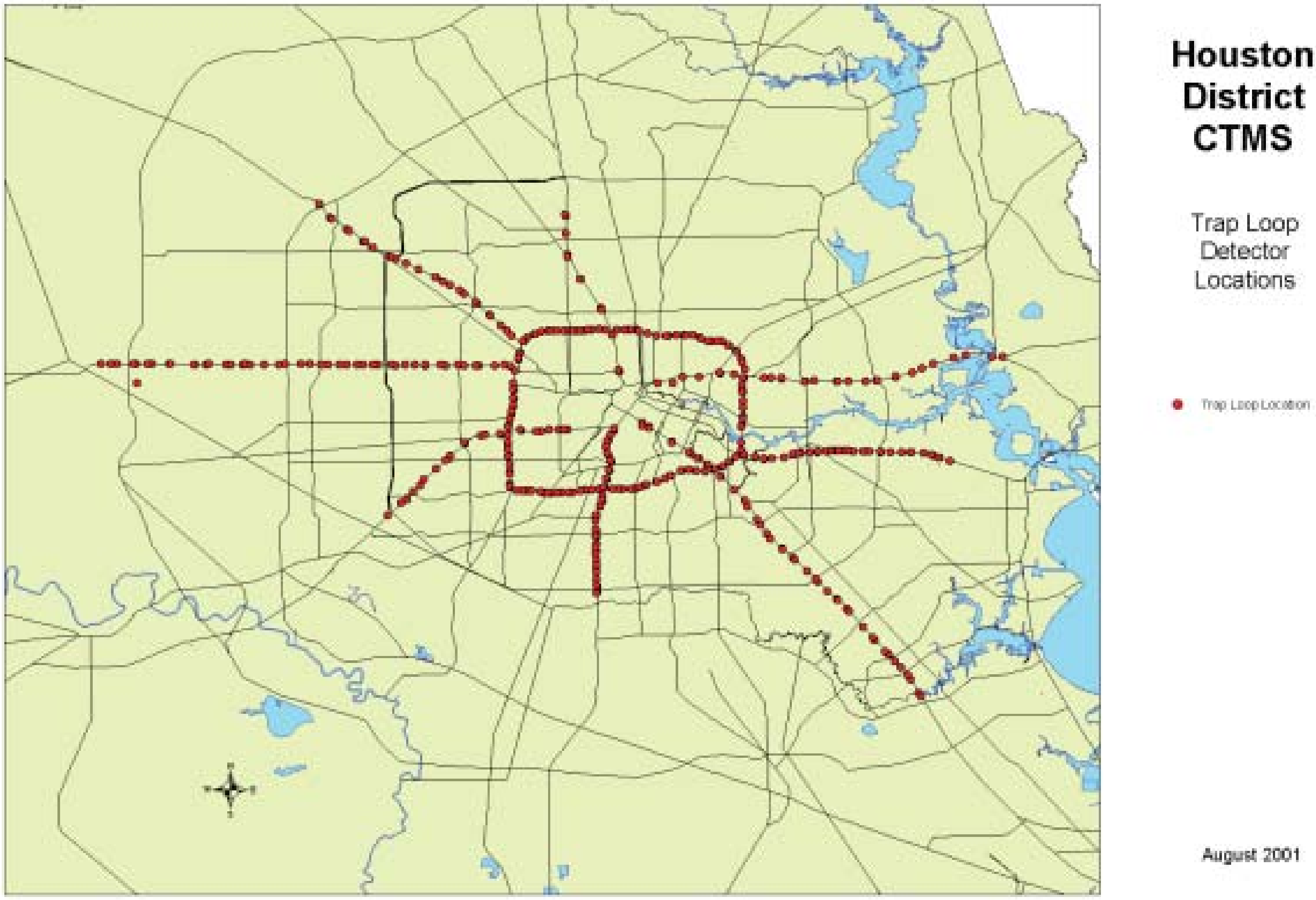

Figure 3-3: TxDOT Trap Loop Detector Locations

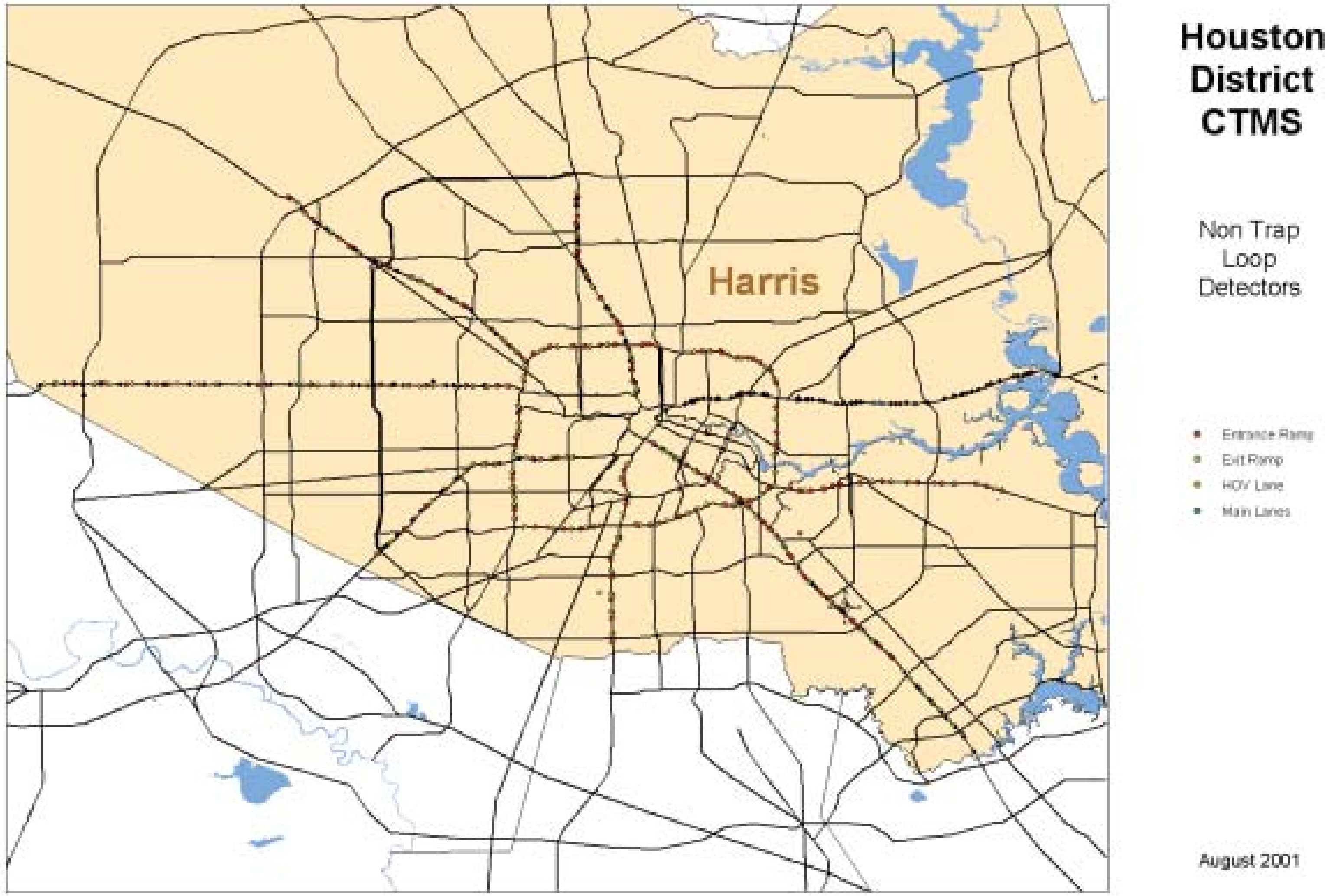

Figure 3-4: Non-trap Loop Detector Locations

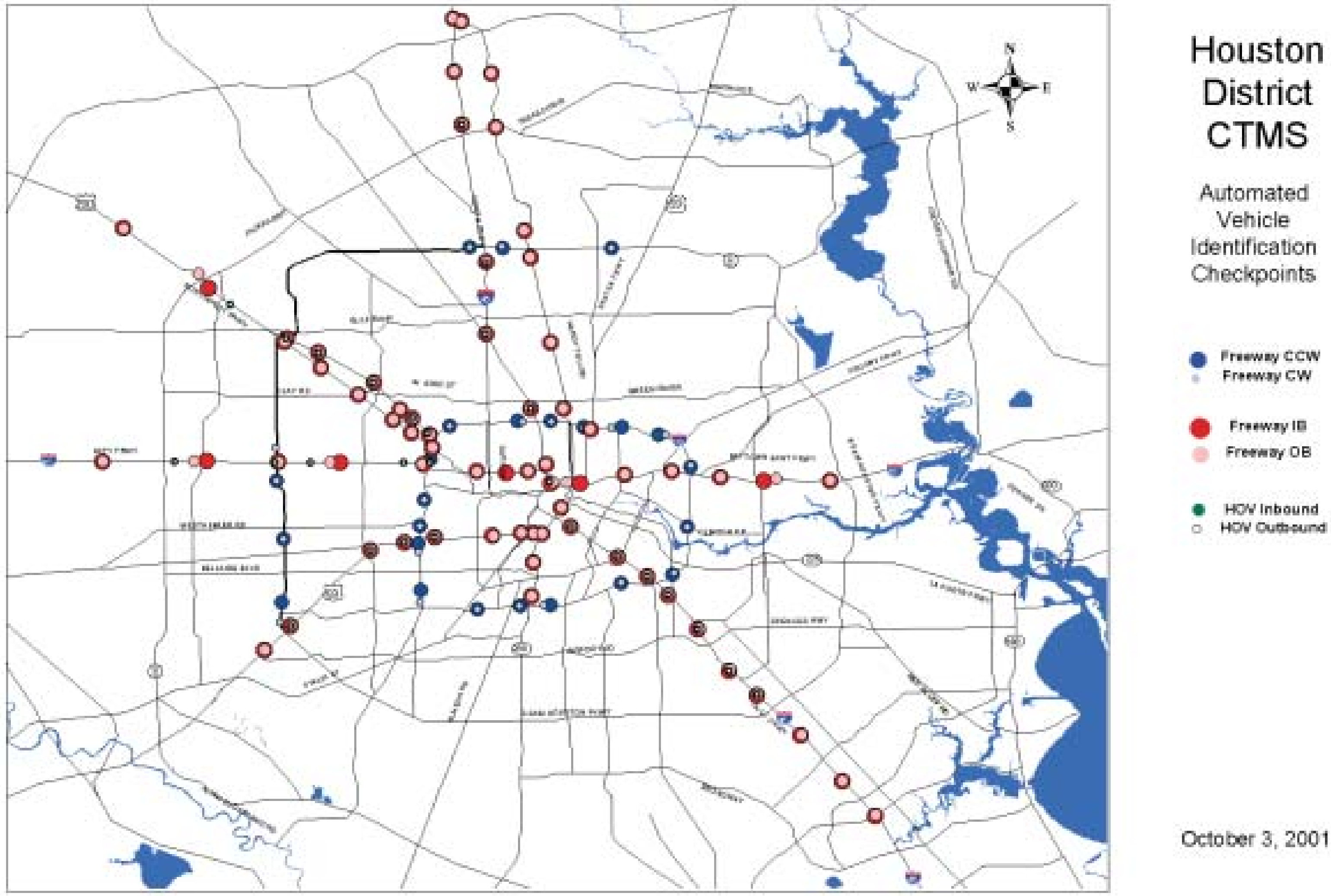

Figure 3-5: AVI Data Collection Checkpoints

3.1.2.4 Video Imaging and Vehicle Detection Systems. Video imaging and vehicle detection systems (VIVIDS) have been deployed at various locations in the region for freeway applications. VIVIDS at several locations are being used as count stations. Some have also been deployed for use in conjunction with ramp meters to regulate traffic flow entering freeways.

3.1.2.5 Flood and Weather Warning Systems. The proximity of the Houston region to the gulf coast makes it susceptible to storms and flooding conditions. The offices of the National Weather Service and the Tropical Prediction Center monitor weather conditions and forecast storms and tornadic signatures using Satellite Weather Maps and the state-of-the-art Doppler Radar Imagery. Timely alerts and warnings are received at TranStar directly from the two offices. Information regarding impending or prevailing weather conditions, ozone levels, and other hazardous conditions in the region are provided to the media and the public via the Harris County Office of Emergency Management (HCOEM) web page located at URL http://www.hcoem.org/.

The National Weather Service, Harris County Office of Emergency Management, Corps of Engineers and River authorities have also established a network of rain and river flood sensing devices to collect data for flood warning purposes. An automated monitoring and forecasting tool is used to monitor rainfall and stage levels activities at 125 sites in the Harris County. In addition, 38 TxDOT road-flooding sensors including four road ice detection sensors and four full weather stations are deployed at strategic locations on hurricane evacuation routes. Warnings and alerts on precipitation accumulation and bayou elevations are issued to the cities within Harris County, emergency management centers, media and the public through the National Oceanic Atmospheric Administration Wire Service (NOAA Weather Radio Station) and the weather wire media. The Harris County Flood Alert System also pages emergency personnel regarding precipitation accumulation and bayou elevation alarms.

Figure 3-6 illustrates the HCOEM flood station/gauge locations in the region.

Through partnership between the Harris County Office of Emergency Management and the Texas Department of Transportation, additional flood sensors have been deployed at critical locations on freeways. Flood levels at these locations are reported to the public via the Internet.

3.1.3 Control Strategies

Information from surveillance and detection devices is used as input for managing congestion and incidents. Several control strategies have been implemented through ITS deployments. The following control strategies are currently being used in the Houston area:

- Highway Occupancy Vehicle (HOV) Lanes
- Flow Signals at Freeway Entrance Ramps
- Signal Network
- Changeable Lane Assignment Signs
- Lane Control Signals
- Motorist Assistance Patrol Program
- Emergency Vehicle Preemption
- Heavy Duty Wrecker Contract

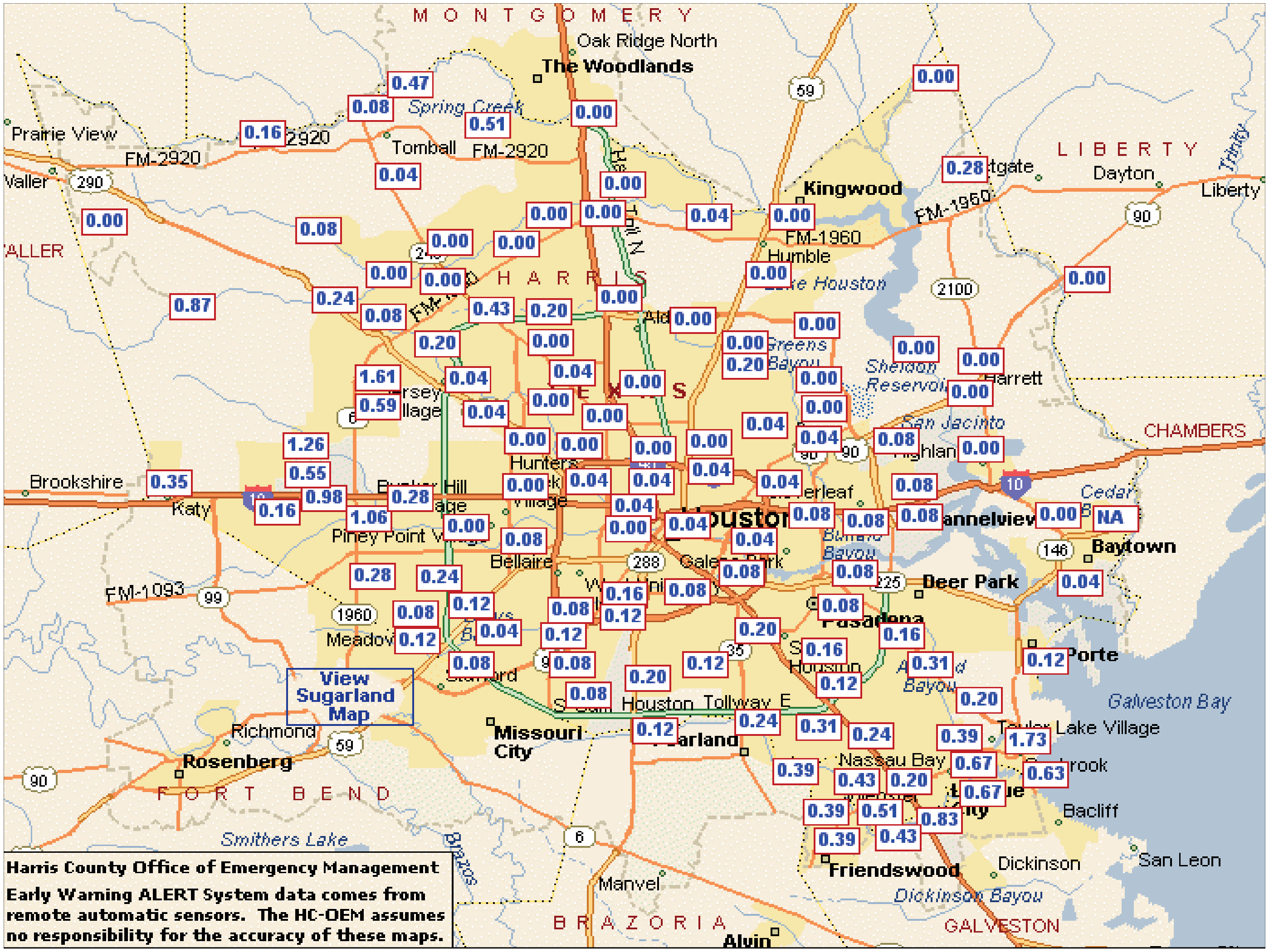

Figure 3-6: HCOEM Flood Station/Gauge Locations

3.1.3.1 <u>High Occupancy Vehicle Lanes</u>. Two separate types of HOV facilities are used in the Houston area. These include:

- Reversible barrier separated HOV Lane
- Concurrent non barrier separated HOV Lane

3.1.3.1.1 <u>Reversible Barrier-Separated HOV Lanes</u>. Houston's HOV lane system is the largest concrete barrier-separated system in the world. Located in the median of freeways, most of the HOV lanes are reversible. Constructed initially as exclusive bus lanes, the system now handles cars, vanpools, and motorcycle as well. A majority of the trips originate from one of the 25 park and ride lots located adjacent to HOV lanes and accessible through direct ramps. The park and ride lots also provide approximately 32,000 free and secure parking spaces for commuters to park and use buses to commute for their work. In addition, three park and pool lots are also available.

HOV lanes are operational on the Southwest, Gulf, Katy, North, Eastex and Northwest freeways. Completed are nearly 94.4 miles of barrier separated reversible HOV lanes. In addition, there are 6.6 miles of concurrent flow non-barrier separated HOV (Diamond lanes) on IH-10 (Katy freeway). HOV lanes are open 5 to 11 a.m. Monday through Friday for inbound traffic, and 2 to 8 p.m. Monday through Friday for outbound traffic. The Katy HOV and the Northwest HOV lanes are operated as High Occupancy Toll (HOT) lanes during peak hours. The lanes are restricted to vehicles with 3 or more occupants. Vehicles with two occupants are also able to use the lanes by paying a toll collected through an electronic toll system. The Katy HOV is the only HOV lane open during the weekend with hours of operation being 5 a.m. to 8 p.m. outbound on Saturday, and 5 a.m. to 8 p.m. inbound on Sunday. Minimum vehicle occupancy on HOV lane ranges from two to three passengers per vehicle on different freeways.

3.1.3.1.2 <u>Concurrent Flow HOV Lanes</u>. In 2001, METRO opened the Katy Diamond Lanes, a barrier-free 6.6-mile extension of the IH-10 HOV lane from Texas 6 to Grand Parkway. The Katy Diamond Lanes, designed and built by the Texas Department of Transportation, are accessible during regular HOV hours. However, a minimum of three occupants per vehicle is required to use the HOV lanes during morning (6:45 a.m.-8 a.m.) and evening rush hours (5 p.m.-6 p.m.).

3.1.3.1.3 <u>Value Pricing (QuickRide) Program</u>. QuickRide is a special carpool program operated by METRO that is available on the Northwest Freeway (US- 290) during the morning rush hour and on the Katy freeway (IH-10) HOV lanes during the morning and evening rush hours. This program allows vehicles with two passengers to use the HOV lanes during the 3+ carpool time period at a fee charge of $2.00 each way. This process is manually enforced on the Northwest freeway inbound entrance between 6:45-8:00 a.m., and on the Katy freeway inbound and outbound entrance between 6:45-8:00 a.m. and 5:00 - 6:00 p.m. respectively.

The program initially requires a person to form a 2-person carpool and fill out an application. Once METRO approves the application, a credit card secured QuickRide account is created. The applicant receives an automobile ID (a rear view mirror hang tag) and a METRO Trip Tag (a small credit card-sized transponder that is to be attached inside the vehicle windshield). A $40.00 fee is initially charged to the credit card, and $2.00 is deducted each time from this account as the applicant uses the 290 or Katy Freeway HOV lanes. Whenever the balance on the account falls below $10.00, the credit card is charged to raise the balance back to $40.00. In addition, a deposit of $15.00 for the Trip Tag and a monthly service fee of $2.50 are initially billed to the applicant. If the applicant already possesses a HCTRA "EZ TAG", the same process is followed except that the Trip Tag is not sent and charged to the applicant. The EZ TAG number is used by METRO for billing purposes. Enforcement is performed manually by METRO Police.

3.1.3.2 Flow Signals at Freeway Entrance Ramps (Ramp Metering). Flow signals are used on Houston freeways to regulate the flow of vehicles entering a freeway from entrance ramps. This process prevents cars from entering the freeway in clusters, thus enabling a steadier flow of vehicles on the main and slow traffic lanes of the freeway. Currently 128 flow signals are operational on Houston freeways. The ramp flow signals are actuated by loops cut into the pavement of the ramp and/or operate by time of day.

Figure 3-7 illustrates flow signal locations on Houston freeways.

3.1.3.3 Signal Network. There are approximately 3,000 signalized intersections within the Houston metropolitan area. The intersections are currently being operated and maintained by various local agencies. In an effort to increase efficiency, a Regional Computerized Traffic Signal System (RCTSS) is being developed to provide coordinated traffic signal operation, traffic management capabilities and upgraded traffic signal hardware for over 2800 planned signals. The signals will communicate through a network composed of fiber optic cable, twisted pair cable, and Cellular Digital Packet Data communication. TranStar will serve as the central facility for RCTSS.

The system will allow operators at Houston TranStar to monitor signals for faults. In addition, signal timings for special events such as the Rodeo and other sporting events may be modified remotely. RCTSS will also enable signal preemption for emergency vehicles and priority signal operation along bus routes. Priority shall be given to buses that are behind schedule.

RCTSS is being implemented through a combination of funding resources. Federal transit funds are being used to fund approximately 1,350 intersections. The Federal Highway Administration (FHWA) has appropriated Congestion Mitigation/ Air Quality (CMAQ) funding for upgrading and/or building 550 additional signals. Other intersections are being supported by local funds.

In addition to the RCTSS, there are many small closed loop signal systems throughout the area and many standalone signals which operate by time of day.

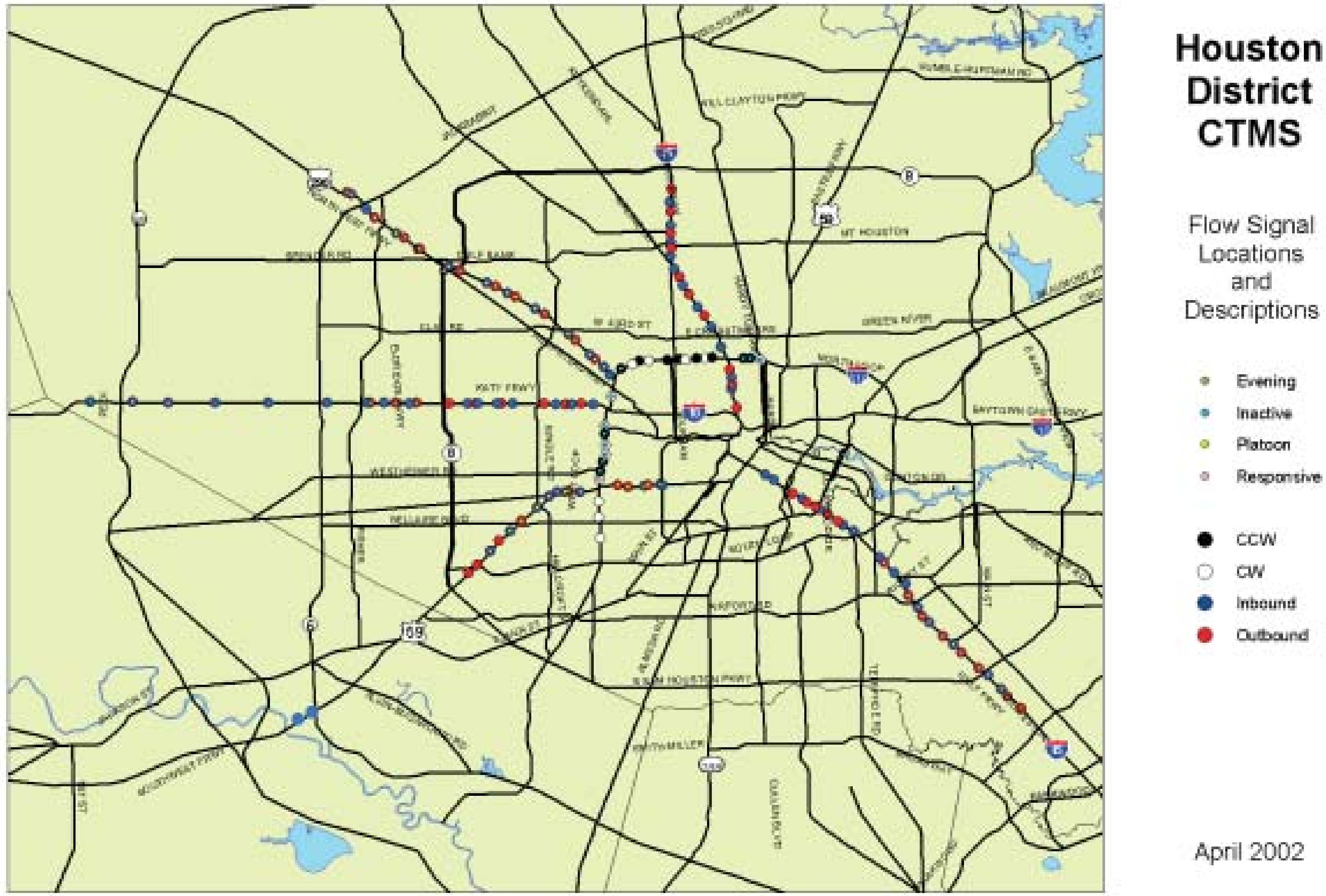

Figure 3-7: Flow Signal Locations and Description

3.1.3.4 Changeable Lane Assignment Signs. Almost all freeways in Houston have been designed and built with continuous frontage roads that run parallel over the entire length. The frontage roads are generally two to three lanes wide and signalized at interchanging cross streets. Thus, traffic volumes on the frontage roads are high and vary during peak and non-peak operation periods. Also, during incidents main lane freeway traffic diverts to frontage roads leading to excessive volumes that causes congestion and excessive delays at signals.

Changeable lane assignment signs (CLAS) on frontage roads address these lane imbalances through dynamic lane assignments using lane signage boards equipped with LED bulbs that indicate current lane usage. The CLAS signs control the number of through and right turn lanes for traffic movement, taking into consideration both the time of the day traffic variation as well as prevalent freeway conditions. Dynamic lane assignment signage is controlled and updated by an operator at TranStar based on the freeway and arterial traffic conditions.

3.1.3.5 Lane Control Signals. Lane control signals are used on freeways for improving traffic mobility and safety. On freeways the lane control signals indicate the condition of an upcoming lane of traffic. The signals convey the following:

1. A green (arrow) signal indicates open freeway lanes ahead
2. A yellow (arrow) signal indicates freeway lane condition ahead that requires extra caution or speed reduction due to an accident, merging lanes, construction, etc.
3. A red (X) signal indicates a freeway lane closure ahead.

Several lane control signals have been deployed on HOV lanes but have been disabled to support current lane operational procedures. Lane control signage is also being used on Studemont for a reversible center lane arterial which allows 2 lanes of traffic to travel in the peak direction.

Currently 89 lane control signals have been deployed in the Houston area. Table 3-2 illustrates their distribution on the freeways and HOV lanes in the region.

Table 3-2: Lane Control Signals on Freeways and HOV Lanes in the Houston Area

Freeway	Number of Stations
I-45 Gulf Freeway	7
I-45 North Freeway	4
I-45 Gulf HOV	17
I-45 North HOV	17
I-10 Katy HOV	14
US-59 SW HOV	11
US-290 Northwest HOV	19
Total	**89**

3.1.3.6 Motorist Assistance Patrol Program. The Motorist Assistance Patrol (MAP) program is a traffic management program designed to assist stranded motorists and remove disabled vehicles from travel lanes. MAP consists of a fleet of vans and pick up trucks driven by officers of the Harris County Sheriff's Department that patrol the freeways from 6:00 a.m. to 10:00 p.m. Monday through Friday. MAP vehicles patrol approximately 150 freeway miles in Houston. The dispatchers can be reached free of charge through Cingular by dialing *MAP or 713-CALL-MAP on the regular telephone system. The vans are equipped to handle problems such as:

- Jump starting a vehicle
- Assist in changing a flat tire
- Assist with minor engine repairs
- Provide fuel or water
- Push a stalled or disabled vehicle from the travel lanes
- Transport a motorist to a safe location
- Summon additional help (relatives, friend or wreckers)

MAP is a joint public/private partnership that include the following agencies providing various services:

- Texas Department of Transportation: Receiving calls and dispatching the deputies
- Metropolitan Transit Authority: Provide funding of deputies salaries
- Harris County Sheriff's Department: Administration of MAP unit deputies, providing fuel and maintenance of the vehicles
- Houston Automobile Dealers Association: Provide four new vehicles to the program each year
- Cingular Wireless Telephone Company: Provide telephone equipment to the deputies for calling in towing assistance and contacting service providers. Provide free airtime to motorist calling the *MAP help line
- Pennzoil: Provide non-flammable alternative fuel at cost to the program.

Figures 3-8 and 3-9 illustrate the MAP and Heavy Duty Wrecker coverage areas, respectively, on Houston freeways.

3.1.3.7 Emergency Vehicle Preemption. Emergency vehicle preemption at signalized intersections is designed to reduce emergency response times through improving emergency vehicle operations during emergency conditions and situations. The traffic signal preemption system uses the 3M OPTICOM equipment. The system uses an infrared transmitter installed on Emergency vehicles to send a signal to the equipped intersection. The receiver mounted at the intersection then receives the signal and the controller adjusts the timing at the intersection by extending the green time for the approach or shortening the red phase.

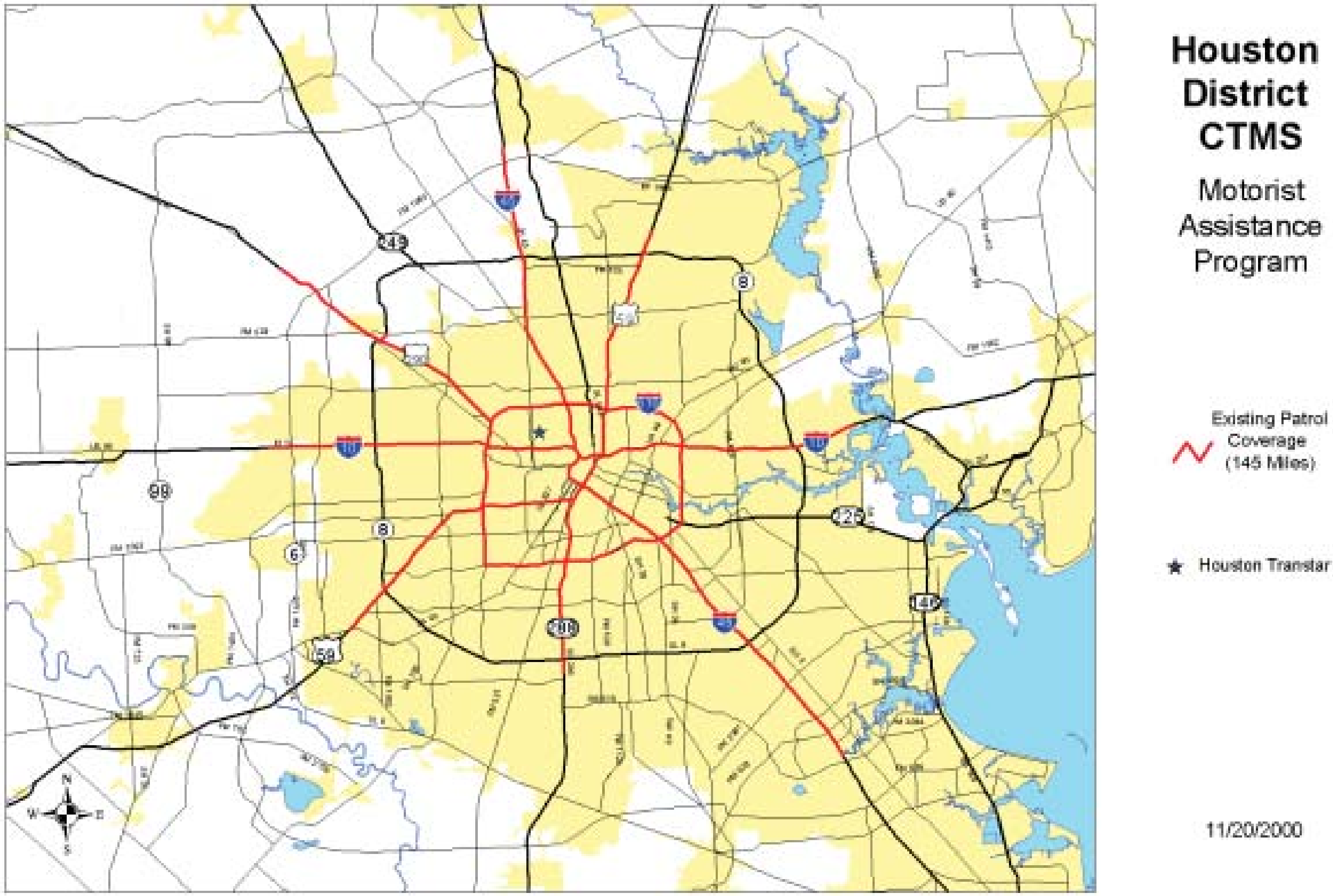

Figure 3-8: MAP Coverage

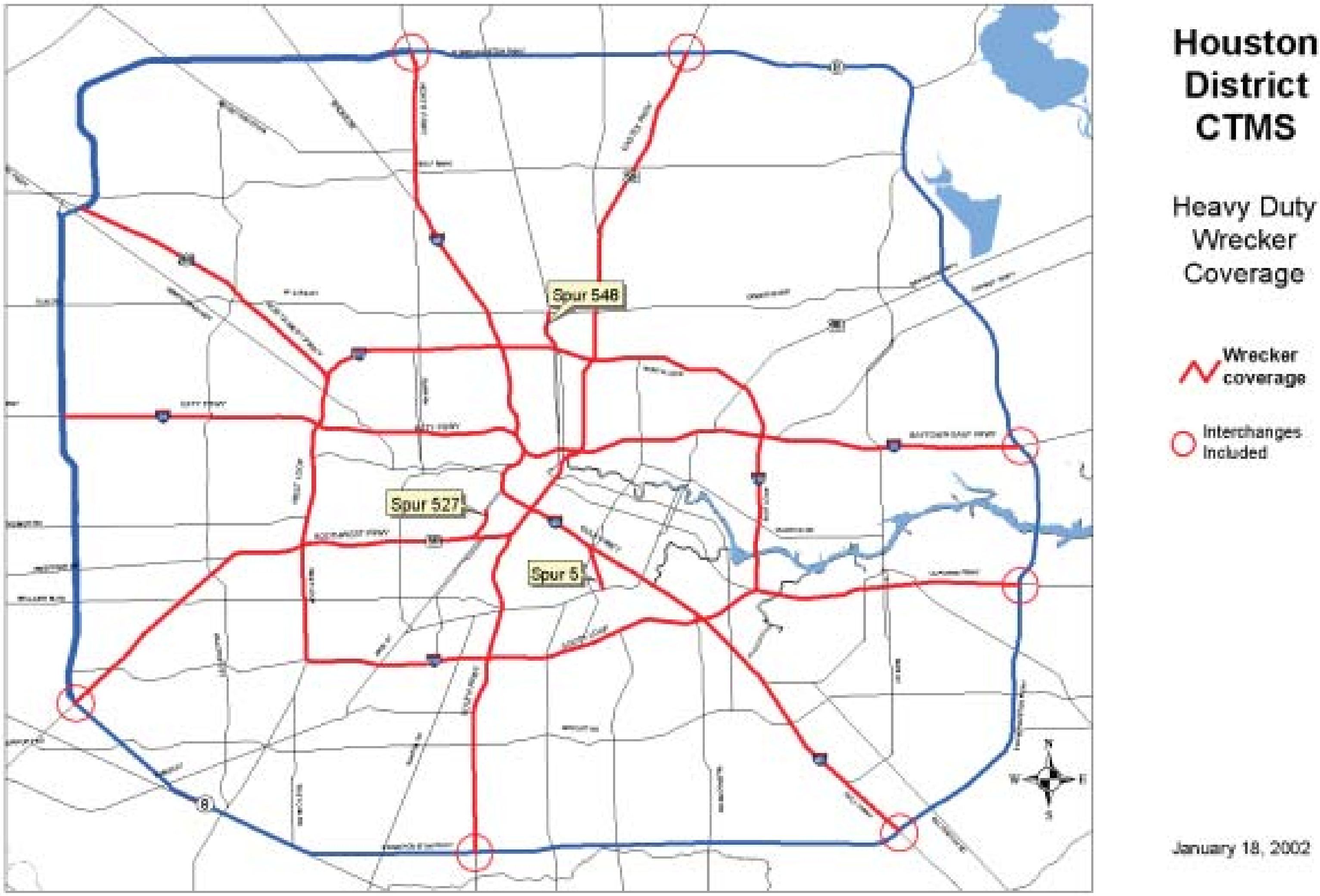

Figure 3-9: Heavy-Duty Wrecker Coverage

3.1.3.8 Rail Monitoring. TxDOT has recently implemented a rail monitoring system in Sugar Land in Fort Bend County. The rail corridor extends along US90A between SH 99 and Kirkwood. The system utilizes Doppler radar data to track real-time train movements within the corridor. The data is processed to provide real-time train location, direction, and speed information on a rail map. The map, sponsored by TxDOT, is hosted in coordination with the Texas Transportation Institute, and is accessible at the rail website located at URL http://raildata.tamu.edu. The rail map is updated every 10 seconds and uses color-coded icons to depict real-time train location as well as the status at various railroad crossings as a train moves along the corridor. In addition, a table supplements the map information and indicates the estimated train arrival and departure times at various railroad crossings. Police and fire dispatch utilize this information to monitor railroad-crossing closures during an emergency response.

Figure 3-10 shows the TxDOT rail monitoring web page.

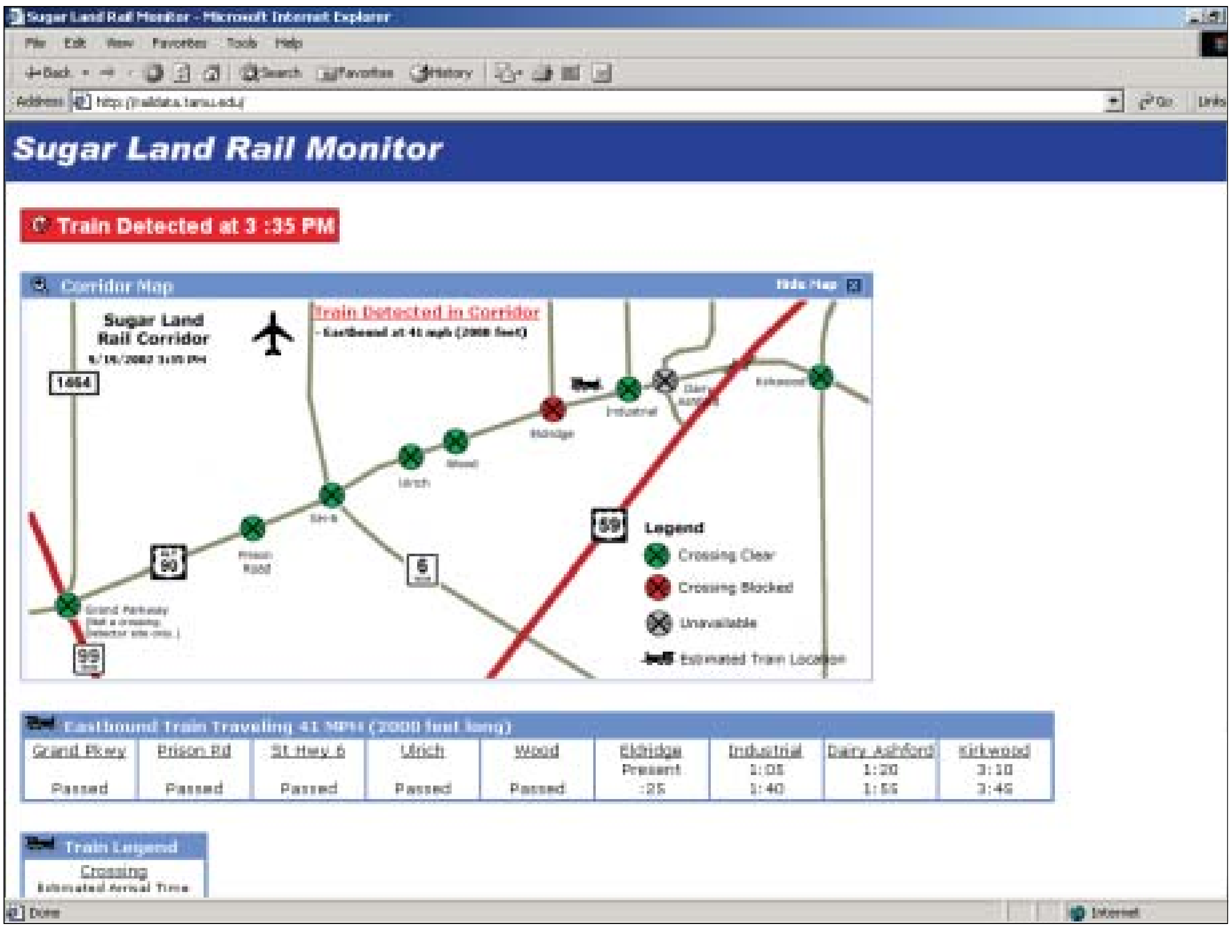

Figure 3-10: TxDOT Rail Monitoring Web Page

3.2 Traveler Information

This section focuses on existing ITS infrastructure and resources available for providing real-time information to travelers and tourists for pre-trip and/or en-route travel planning.

3.2.1 Pre-trip and En-Route Planning

TranStar services include pre-trip and en-route travel information to assist travelers in making mode choices, travel time estimates, and route decisions prior to and/or during trips. Information is integrated from various transportation modes and presented to the user for effective decision-making. Traffic information is delivered to the public through various web pages which include TranStar's web page (www.houstontranstar.org), TxDOT's web page (www.dot.state.tx.us), and the TxDOT sponsored web page hosted in coordination with the Texas Transportation Institute (traffic.tamu.edu). In addition, TxDOT maintains a 24-hour traveler information hotline accessible at 800-452-9292 to provide roadway and weather information along all major highway routes in the state. Transit information is available from the METRO web page (www.ridemetro.org) and customer information center.

3.2.1.1 TranStar Web Page. The TranStar partner agencies host several websites that provide valuable information to travelers pertinent to pre-trip travel information, emergency information and preparedness, and environmental issues in the Houston area. The primary website, http://traffic.tamu.edu, is sponsored by TxDOT and hosted in coordination with the Texas Transportation Institute. The second website is a TranStar website located at the URL http://www.houstontranstar.org. Both of these websites provide the same real-time and historical traffic information content and provide links to partnering agencies web pages. In addition, TxDOT's primary website, http://www.dot.state.tx.us/, provides information on prevailing conditions on freeways and HOV lanes as well as construction closures along all major routes across various districts in the state.

Figure 3-11 shows the default web page of the TranStar website hosted by the Texas Transportation Institute.

Real-time traffic information, route guidance and other important information services are provided to the users through various applications including:

- Traffic Map: Presents color coded links that indicate speeds on various segments of the freeway. Clicking on the links allows access to actual average speed charts that depict current, recent and historical speeds on the link. Also, comparison of current speeds and historical average speeds during 5:00 a.m. to 8:00 p.m. at 15 min data intervals are represented graphically along the various links through speed comparison charts.

  Freeway incident locations are indicated through color coded icons on the traffic map. Clicking on an icon provides information regarding the time, location, severity, and status of an incident. In addition, the traffic map illustrates camera locations along various segments of the freeway through icons that link to on-site freeway camera images.

- Text Reports: Text reports for individual freeway links supplement the traffic map and provide information on the following:

    - Link origin/destination
    - Link length
    - Average travel time
    - Average travel speed

- Construction Closures: Information on current construction and emergency closures on freeways at different time periods is also provided.

- Route Builder: The website offers provisions for pre-trip route planning through selection of the best travel route based on current freeway conditions.

- Links: The website provides links to web pages of all partner members and other concerned agencies including emergency management, weather services, and environmental agencies.

TranStar traffic information can also be accessed via handheld Internet devices including wireless phones, personal digital assistants (PDAs), and pagers. Wireless users can access freeway incident information and travel times by browsing the URL http://traffic.tamu.edu/mobile.

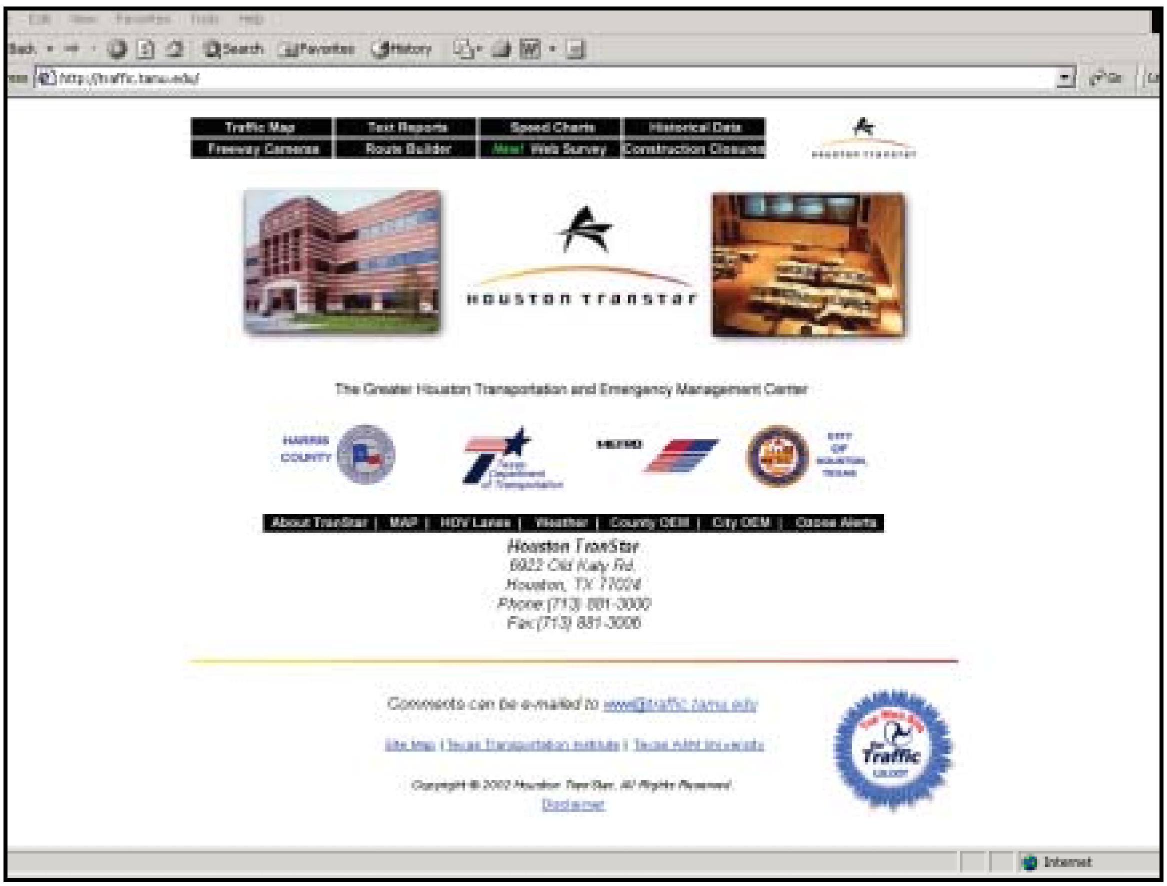

Figure 3-11: TranStar Web Page

3.2.1.2 <u>Harris County Office of Emergency Management Web Page</u>. To address potential threats concerning any natural or man-made disasters and emergencies, the Harris County Office of Emergency Management (HCOEM) offers real-time information and warnings to the media and public via its web page accessible at http://www.hcoem.org/. Information on impending or prevailing weather conditions, ozone levels, and other hazardous incidents in the region are provided through a co-operative effort between the Harris County and other local jurisdictions. Links to various on-site monitoring elements including weather radar imagery and flood sensors are included to provide a first-hand view of the emergency conditions. Additional information including situation reports, evacuation information, and plans and preparations to counter emergencies are also provided. The HCOEM web page was well received during Tropical Storm Allison, and was accessed more than 1.6 million times.

Figure 3-12 illustrates the HCOEM web page.

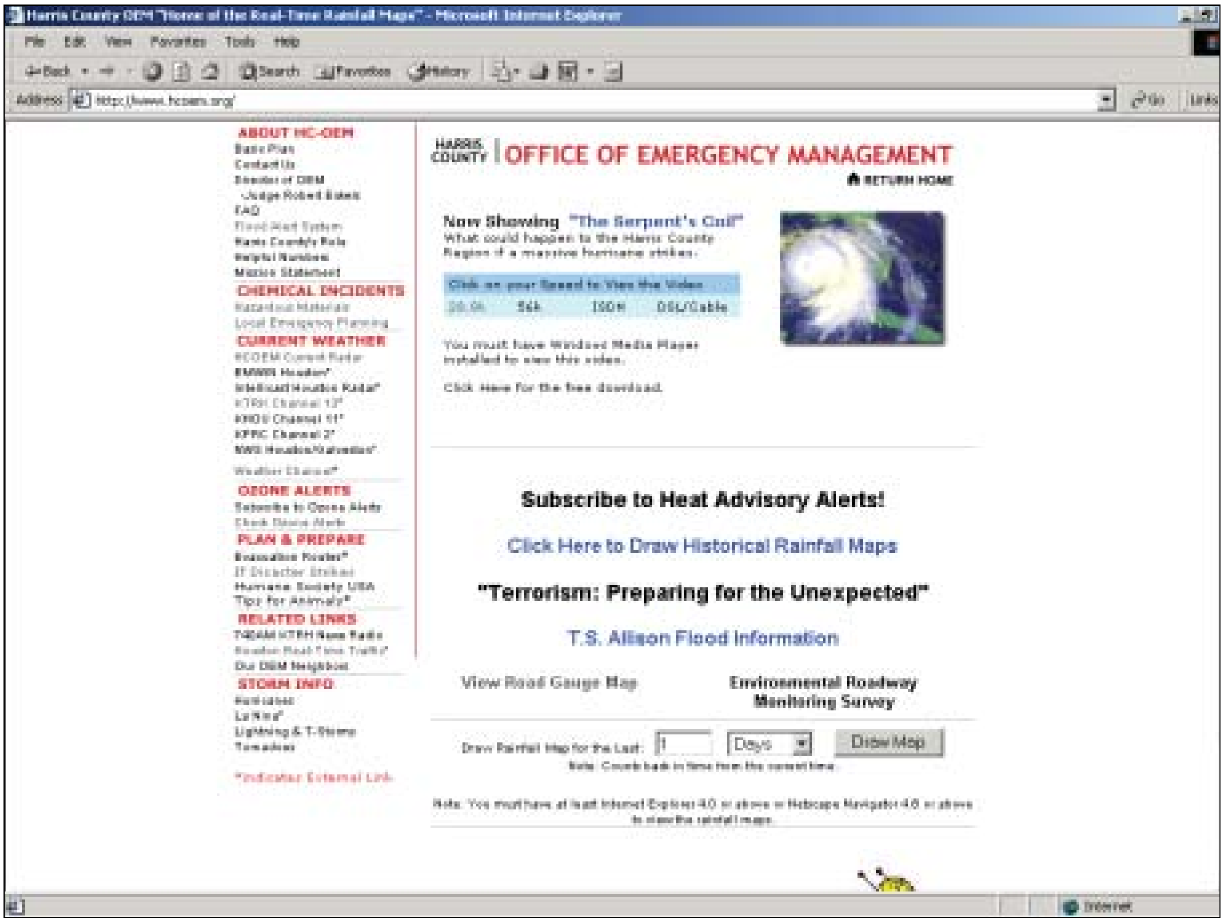

Figure 3-12: HCOEM Web Page

3.2.1.3 <u>METRO Web Page</u>. METRO provides valuable information on its projects, programs, and services offered to the public through its web page accessible at the URL http://www.ridemetro.org. The web page includes links to a variety of METRO commuter services and programs including METRO Bus, METROLift, QuickRide, and METROVan. In addition, information and links to METRO administered services including METRO Police, HOV lanes, and MAP are also provided. A route information tool has recently been added to the web page that allows patrons to view detailed stop, route, and estimated bus arrival times at various en-route street intersections for all METRO buses. Also, a new service called METROLink has been launched whereby patrons can register to receive free bus schedule information and updates via e-mail on their selected routes. This helps patrons to effectively pre-plan trips. The web page also includes customer service contact information for various METRO programs and services for any additional information.

Figure 3-13 illustrates the METRO web page.

Figure 3-13: METRO Web Page

3.2.1.4 <u>Texas Travel Information System</u>. The statewide Texas Travel Information Center hosts a toll free statewide telephone number, accessible at 800-452-9292 and is managed by TxDOT. Available here are prerecorded messages describing weather reports and known road conditions in the state. Users are able to search by region, county, or city. Detailed information on weather forecasts and freeway lane closures enable pre-trip and on-route travel planning, which improves mobility and prevents delays.

3.2.1.5 <u>METRO Line</u>. METRO maintains a semi-automated transit information hotline (METROLine) accessible at 713-635-4000. This service, available in English and Spanish, offers information regarding bus services, special event shuttles, rideshare, HOV lanes, vanpooling and an opportunity to leave comments or suggestions. METROLine is supported by a large customer service center where operators are available to help the public with information on fares, schedules, updates, and other transit related issues. This hotline service enables commuters to effectively pre-plan their trips.

3.2.1.6 TxDOT Houston District Construction Hotline. TxDOT hosts a Houston district semi-automated construction information hotline accessible at 713-802-5074. This service offers information regarding pre-scheduled freeway lane construction closures, their duration, and detour routes at respective lane closure sites. Lane closure information is grouped based on the geographic location of freeways, which allows travelers to easily access information pertaining to their travel routes. In addition, TxDOT operators are available during business hours to help customers with specific route information, construction project information, and other traveler related issues. This enables travelers to effectively pre-plan their trips, and avoid congestion and delays.

3.2.1.7 Dynamic Message Signs. Dynamic message signs (DMS) are used to deliver information pertinent to downstream traffic conditions, travel times, road closures and alternative routes to the traveling public. There are approximately 154 DMS deployed in the Houston/Galveston area, with plans to deploy additional signs throughout the area. The DMS are operated remotely from TranStar through fiber optic cable and telephone dial-up connections. Operators at TranStar develop and initiate messages. The signs are capable of displaying 3 lines of 15-character text with one or two message phases.

Figure 3-14 shows DMS locations on Houston freeways.

3.2.1.8 Highway Advisory Radio. Highway advisory radio (HAR) provides real-time information on traffic conditions, road closures, and alternate routes to drivers tuned into the radio frequency. HAR is currently being deployed in the Houston area. HAR deployments include 11 fixed sites and a portable unit. The 11 fixed sites operate on 1610 and 1680 AM radio frequencies. The portable unit operates either on 530 or 1610 AM frequency depending upon the clarity of the frequency at a particular location. HAR deployments have been completed on various freeways in the region including IH-610, IH-10, US-59, IH-45, and TX-288.

Figure 3-15 illustrates the HAR coverage and the corresponding operating radio frequencies.

3.2.2 Commercial Vehicle Travel Advisory System

The Commercial vehicle travel advisory system (CVTAS), deployed by TxDOT, delivers real-time traffic, weather, road closures, and detour information to truck operators. CVTAS application through DMS and HAR deployments is planned to detour truck traffic when major routes are blocked. When conditions warrant the need to reduce congestion, truck traffic shall be detoured from the city through the ring highways (Beltway 8, IH-610, SH 99 or HCTRA Toll Roads) or may be re-routed from the city outskirts.

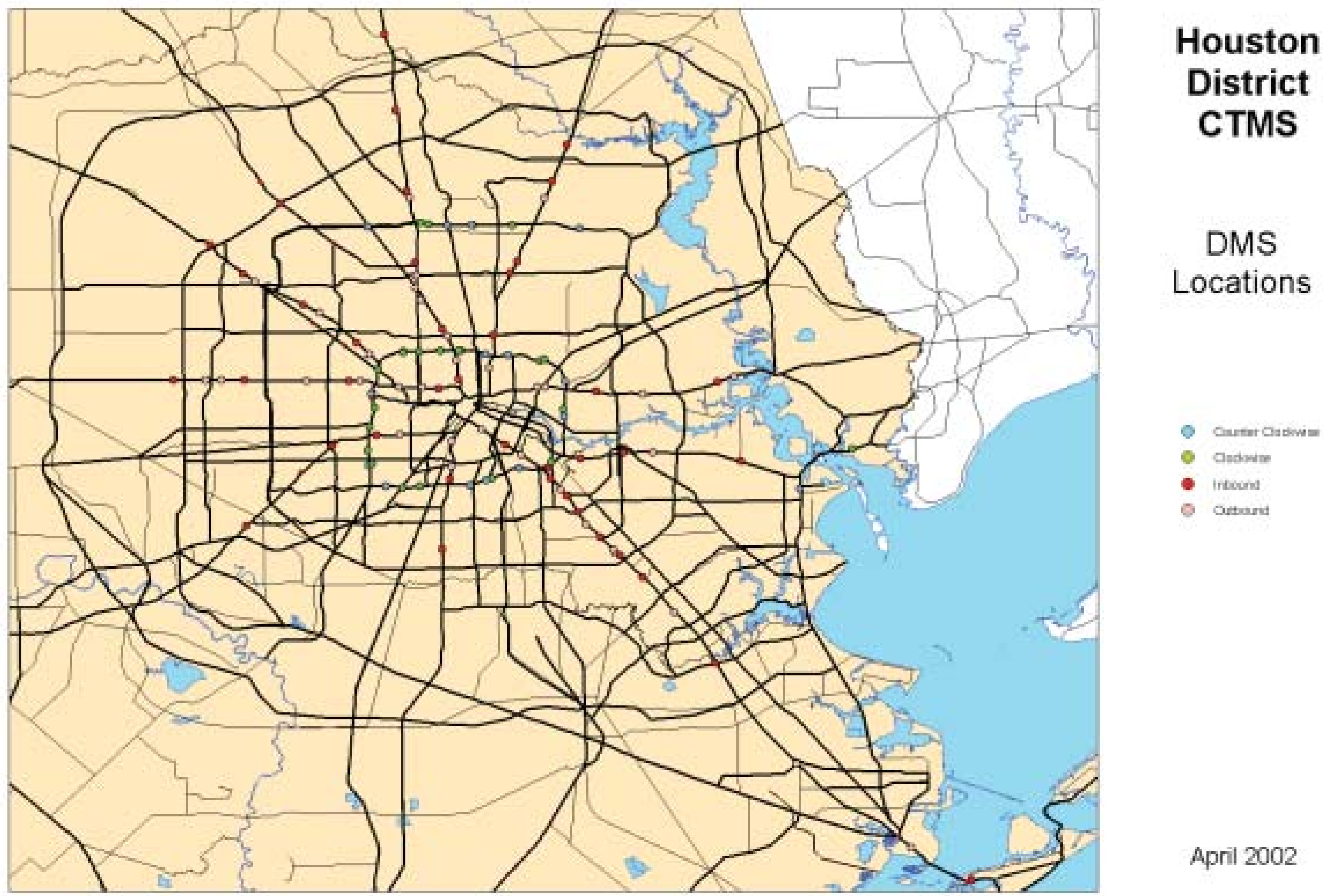

Figure 3-14: DMS Locations and Descriptions

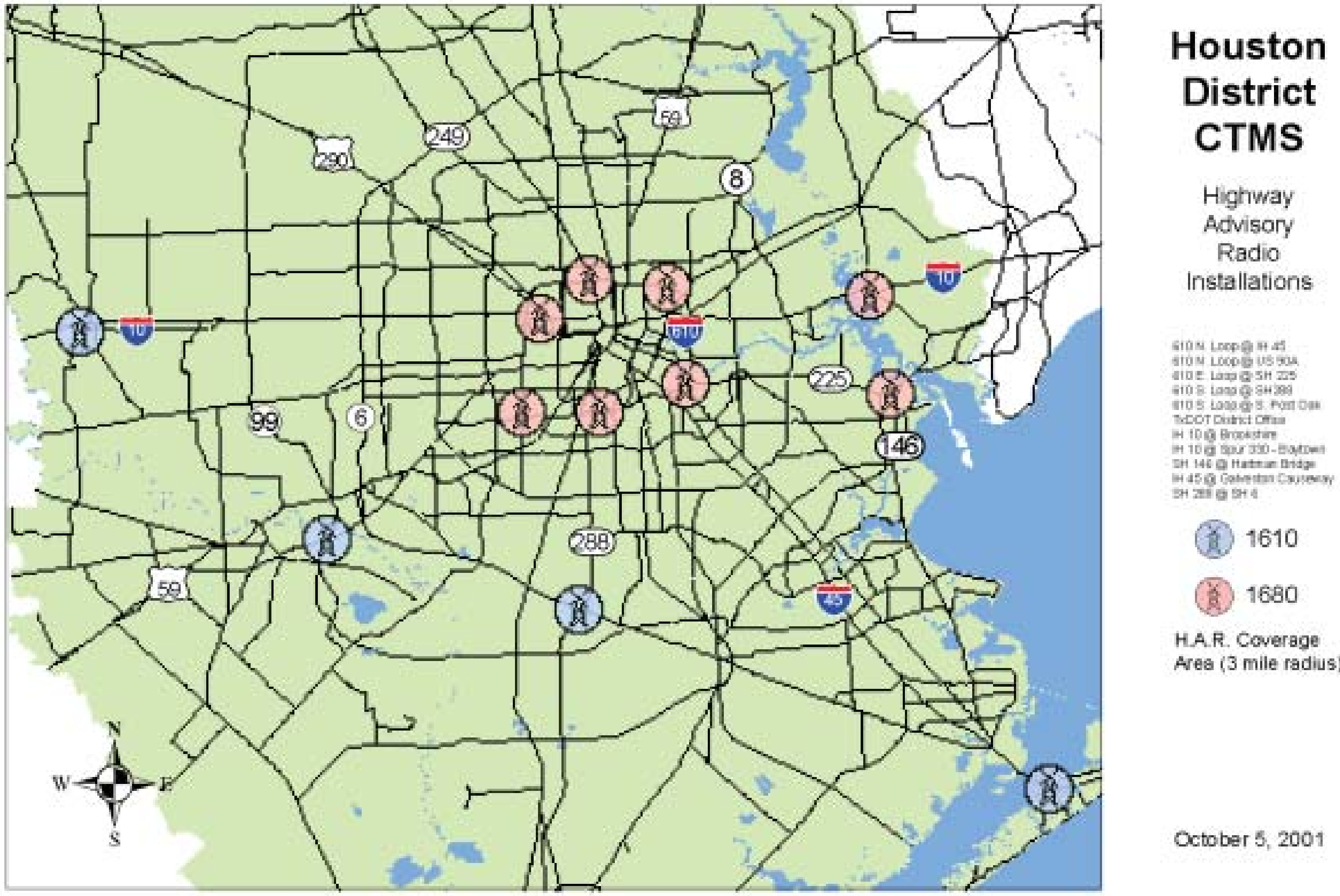

Figure 3-15: HAR Coverage and Radio Frequencies

3.2.2.1 Dynamic Message Signs. Nine DMS sites have been selected for deployment by TxDOT in rural areas along IH-10 west from Beaumont to Houston and IH-10 east from San Antonio to Houston. This project is a partnership between the Houston, San Antonio, and Yoakum Districts of TxDOT, and will enable real-time information and device sharing between districts to allow dissemination of vital information to commercial vehicles in rural sections of the state before they reach Metropolitan areas. In addition, TxDOT has plans to deploy DMS signs for Commercial Vehicle Operation application at 12 locations within the Houston region. These planned locations include US-290, IH-45N, US-59N (Eastex freeway), IH-10E, IH-10W, and US-59S (Southwest freeway). The DMS signs shall provide real-time information on weather and roadway conditions that could impact commercial vehicle travel or cause them to adjust their time to travel through the Houston area.

3.2.2.2 Highway Advisory Radio. HAR deployments have been deployed by TxDOT at strategic points throughout the Houston area to alert commercial vehicle traffic of adverse conditions. Text to speech technology may be used for consistent high quality voice messages to be broadcasted on HAR. This process will significantly reduce the cost and time for generating new messages pertinent to conditions, and will increase the frequency for information updates. Current HAR operations in the Houston area are not CVO specific as they provide traveler information to both general public and commercial vehicles. HAR deployment sites at the city outskirts shall initially be along IH-10 and will primarily benefit commercial vehicles passing through the Houston Metropolitan area on the freeway.

The planned DMS and HAR deployments shall be integrated fully with other ITS deployments operational in the region.

3.3 Electronic Payment Systems

Electronic Payment Systems (EPS) support a transportation payment infrastructure for various transportation modes through the development of payment facilities that minimize stops and corresponding delays at collection facilities. EPS in Houston are supported through electronic toll collection and the Value Pricing Program known as QuickRide, which is available through METRO on the Katy (IH-10) and the Northwest (US-290) freeways.

3.3.1 Electronic Toll Collection

Electronic Toll Collection (ETC) technology enables electronic payment of tolls through incorporation of vehicle-to-roadside communication technologies including Automatic Vehicle Identification (AVI) and Automatic Vehicle Classification (AVC). The technology application enables an electronic monetary transaction between a vehicle transponder “EZ Tag” and toll station as the vehicle passes through it. ETC equipment supplements the traditional manual toll collection systems at tollbooths and allows transactions to be performed with vehicles traveling at near highway cruising speeds.

ETC allows customers the flexibility of paying toll bills with credit cards or electronic funds transfer (direct debit). This facility enables an automatic recharge of the EZ Pass as the toll account reaches a predefined level ($ 10.00 for credit cards and $25.00 for Direct Debit).

The Harris County Toll Road Authority (HCTRA) oversees all tollway operations and management services. Currently, the toll road system covers approximately 96 miles of roadway in the Houston region. There are nine mainline plazas, seven of which are along the Sam Houston Tollway and two on the Hardy Toll Road. Each tollway offers three types of services:

- EZ TAG only – Designated exclusive lanes represented by yellow "^EZ TAG ONLY^ " signs for "EZ Tag" patrons. EZ Tag lanes may be used by any classification of vehicle, from motorcycle to commercial vehicles.
- Coins-Tokens only – Designated exclusive lanes for vehicles (cars without trailers) paying through tokens or exact change represented by green canopy signs reading "COINS-TOKENS ONLY." HCTRA is planning to eliminate the use of tokens in the future.
- Full Service – Collector attended toll lanes represented by a blue "FULL SERVICE/ RECEIPTS" sign for all patrons using dollar bills and those purchasing tokens. EZ Tag transactions can also be processed in some locations where the smaller EZ TAG sign is posted below the blue sign verbiage. These lanes are usually 10 to 12 feet wider than EZ TAG lanes and can process multi-axle vehicle and passenger car transactions.

Figure 3-16 illustrates the various toll collection lanes and the supporting guide signs.

Figure 3-16: Toll Collection Lanes and Guide Signs

HCTRA's nine toll plaza facilities comprise 26 manual lanes, 50 automated lanes, and 162 mixed-use lanes. An Automated Toll & Traffic Law Administration System (ATLAS) using digital camera technology for enforcement has been deployed at all toll plazas in Houston. The digital camera system photographs the license plate of violator vehicles using optical character recognition tools for speeds up to 100 mph. These captured images are transmitted to a Violation Processing Center where the ATLAS system automatically uploads the images and identifies the license plate numbers, looks up the registered owner, and issues violation notices via mail.

3.4 Communications

Communications provide the connectivity to support the implementation of advanced technologies. It enables real-time data transfer back and forth from field equipment to the TMC. This enables implementation of regional transportation and emergency management services through effective coordination among agencies and subsystems. Communication in the Houston area is supported through Fiber optic cables, Cellular Digital Packet Data (CDPD), Harris County Radio System (HCRS), twisted pair copper cables, and leased lines. Recently, a high-speed (22 mbps) wireless link connection using WLAN 802.11b protocol has been established between TranStar and the Texas Transportation Institute building at Post Oak Boulevard.

3.4.1 Fiber Optic Communication Network

The fiber optic communication network forms the backbone for communication between Houston TranStar and field equipment. TxDOT has deployed single mode and multimode fiber optic cable along much of the freeway. Harris County, the City of Houston, METRO and the Harris County Tollroad Authority have also deployed fiber at various locations. Current efforts are underway to convert the system to an Asynchronous Transfer Mode (ATM) based communication to support a mesh type network configuration.

Figure 3-17 illustrates existing installation of fiber optic cable.

3.4.2 Cellular Digital Packet Data (CDPD)

Cellular digital packet data is a wireless digital radio communication technology that utilizes the idle voice channels of the analog cellular network also referred to as Advanced Mobile Phone Service (AMPS). These idle channels are used to transmit short-range data messages in the form of structured packets at speeds up to 19.2 kbps over AMPS. The idle channels or capacity represent unused cellular frequencies that occur as short pauses between the time point a cellular conversation at a particular frequency ends and another call utilizes the same frequency. Sometimes, idle capacity is also created as a person using a particular frequency moves from one area of coverage to another.

CDPD utilizes the Internet Protocol (IP) and Connectionless Network Protocol (OSI CLNP) for wireless communication. It implements a frequency hopping procedure to utilize the available frequencies and incorporates a forward error correction to overcome interference and fading problems.

The RCTSS program is being implemented through CDPD communication on approximately half of the 1,300 networked signals. TxDOT has also used CDPD to transmit real-time train information along the Sugar land rail corridor in the Sugar land/Fort Bend County.

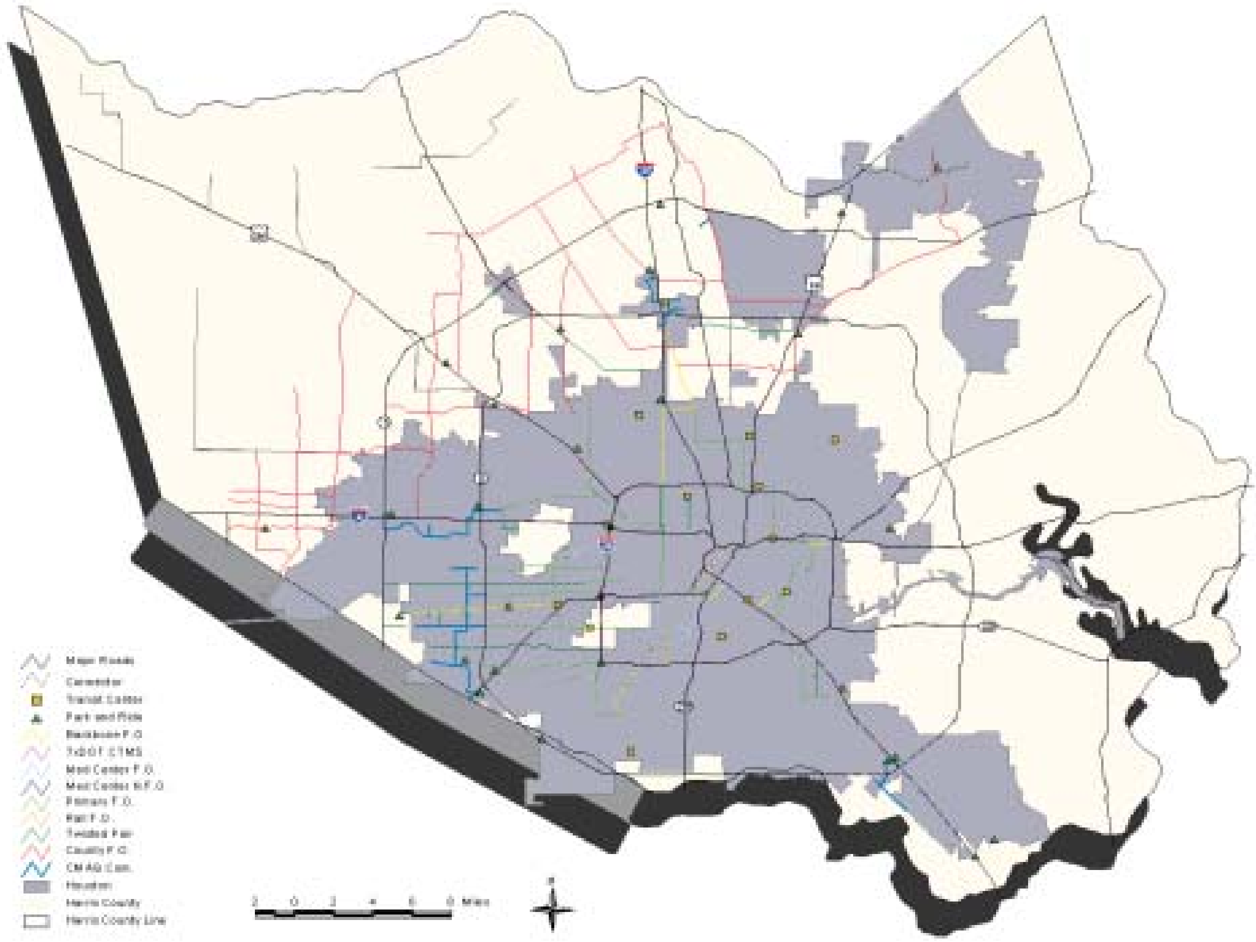

Figure 3-17: Fiber Optic Cable Network

3.4.3 Harris County Radio System

The Harris county radio system (HCRS) is a two-way Motorola Radio system operating at a frequency of 800 MHz. The system comprises 79 channels supporting both voice and data communications at a rate up to 19.2 kbps. Separate voice and data subsystems are built to handle voice and data exchange activities respectively. The HCRS is being used by various agencies for real-time communication and information exchange both within the Harris County as well as surrounding areas. These agencies include:

- Harris County Sheriff Department
- Harris County Maintenance Vehicles
- METROLift
- METRO Police
- Emergency Medical Services (EMS)

METRO Police and EMS use the radio for real-time response to incidents and emergencies. METROLift uses the radio system for real-time vehicle tracking and updating bus scheduling activities as well as reporting any emergencies.

3.5 Transit

Houston METRO operates and manages all transit operations in the region. Currently, 1,572 buses (includes METRO-owned buses and vans operated by private companies under contract with METRO) operate on 130 bus routes covering a 1,285 square mile service area. The METRO transit network incorporates 27 Park & Ride Routes and 25 Park & Ride Lots spanning all over the Houston area. Also, METRO has 15 transit centers where bus riders transfer from one route to another. In addition to its bus services, METRO facilitates commuter's needs through programs such as MetroVAN, Trolley, and the MetroLift service for the disabled. Several other programs such as the Ride sponsor, Ride Share, and QuickRide program have also been implemented to promote commuter pooling in the region.

3.5.1 Advanced Radio Communication System

The Advanced Radio Communications System (ARCS) is a voice and data communication and dispatch system installed on approximately 1,400 vehicles. METRO's ARCS was procured in 1996, with the development and installation completed by Orbital/TMS in 2000. The ARCS provides voice and data communication between bus operators and dispatchers at TranStar.

3.5.1.1 Onboard Subsystem. The onboard subsystem includes a radio unit, a data modem, a processor unit, a handset, and a mobile data terminal that provide buses with data and voice communication and other capabilities. Components are connected via a J1708 communications backbone.

3.5.1.2 Communication Center Subsystem. The communication center subsystem located at TranStar includes a radio base-station equipment, data networking equipment, computer servers that control the network traffic and provide Computer Aided Dispatch (CAD) functions, and dispatch consoles. The primary function of the communication center subsystem is to provide voice and data communications in support of the CAD for all ARCS equipped vehicles.

3.5.1.3 Communication Subsystem. The communication subsystem constitutes the wireless and a wire line communications infrastructure of the ARCS. The ARCS wireless communication provides voice and data messaging services between radio dispatch and transit vehicles using E.F. Johnson Multi-Net trunked radio system. The radio system with 10 channels (7 for voice and 3 for data) operating at 800 MHz frequency uses Time Division Multiple Access (TDMA) technology that allows a large number of users to share access (in a time ordered sequence) to a single radio frequency channel without any interference by assigning unique time slots within the channel.

The wireline communication consists of two components, including a Local Area Network (LAN) that provides communication between the radio-base station equipments and the dispatch consoles within TranStar, and the MetroNet Wide Area Network (WAN) that provides data network services between TranStar and other METRO operation centers. WAN is used to interface remote dispatch units at various METRO operation centers with TranStar.

3.5.2 Computerized Telephone Information System (CTIS)

CTIS is a static interactive response system that provides users with important information regarding bus route and trips, schedules, fares and next bus information at different times of the day. The system can broadly be classified into two categories pertinent to their application:

- Interactive Voice Response System
- Personalized Bus Itinerary Service

3.5.2.1 Interactive Voice Response System. METRO maintains an automated transit information hotline (METROLine) accessible at 713-635-4000. The interactive service, in English and Spanish allows commuters to listen to automated transit information as well as talk with customer service representatives regarding bus routes, fares, schedules, and other transit related services. This service enables commuters to effectively pre-plan their trips.

3.5.2.2 Personalized Bus Itinerary Service. METRO also provides a Personalized Itinerary service that allows commuters to speak with customer service representatives and establish a personalized transit itinerary pertinent to their travel preferences at different time periods of the day. The users are required to indicate the origin, destination, and the time they plan to travel. This information is fed into a computer that utilizes optimization procedures to select the optimal bus route, schedule, and fare that shall minimize commuter travel time during different time periods of the day. Personalized Itinerary service is also offered through the METRO webpage.

3.5.3 Integrated Vehicle Operation Management System (IVOMS)

IVOMS is a future programmed METRO project that plans to integrate advanced state of the art onboard and fixed end technology to enable real-time tracking, schedule adherence, passenger counting and automatic stop annunciation on METRO buses. On board vehicle technologies including Automatic Vehicle Location (AVL) system, Automatic Passenger Counters (APC), Mobile Data Terminal (MDT) and Bus Annunciator shall be installed and interfaced through an onboard Vehicle Logic Unit (VLU). The VLU shall function as the central hub and shall store, process, and coordinate data exchange between the bus and the dispatch unit. The system shall also provide for real time two-way voice and data communication between the bus and the dispatch unit through the onboard MDT.

Real time vehicle location shall be determined every second in the onboard AVL device using GPS information. All real-time communication shall be through the radio system. Other non real-time data exchange including upload of bus schedule information and download of APC and schedule information at bus operating facilities shall be accomplished through wireless LAN. In addition, all information exchange between the TranStar and other facilities shall be through the MetroNet WAN. Signal Priority shall use OPTICOM emitters and communicate to equipped RCTSS intersections.

The IVOMS system when fully operational shall provide real-time vehicle tracking, schedule adherence, passenger counting, bus annunciation and signal priority services enabling uninterrupted effective transit operations.

3.5.4 METROLift

METROLift is a personal public transit service offered to persons with a disability who cannot board, ride, or alight from a regular METRO fixed route buses equipped with a wheelchair lift. This curb-to-curb service is offered through wheelchair-equipped vans, four sedans and minivans that include lift equipped vans and boarding chairs. METROLift services are offered 5:00 a.m. to 11 p.m. on weekdays, 7 a.m. to 12:00 a.m. on Saturdays, and 7:00 a.m. to 11:00 p.m. on Sundays and holidays. Patrons can schedule their trips through calling the METROLift reservations office 7 days a week. On making a reservation, patrons are given an approximate schedule time for their trip, and are needed to verify the same the night before the trip from the dispatch office. The service allows rescheduling or cancellation of trips by notifying the dispatch office at least 30 minutes before the scheduled trip. METROLift accepts Fare cards and monthly passes for ticket payment but does not accept cash. A subscription service is offered on a limited basis to patrons traveling to and from the same location at the same time three or more days per week on a regular long-term basis.

METROLift patrons can use their Americans with Disability Act identification card to access paratransit services in any U.S. city. The service also enables last minute emergency transportation services for patrons through the METROLift Subsidy Program.

METROLift buses use the HCRS, which enables real-time data and voice communication between the bus operator and the dispatch unit located at METRO's Bus Operating Facility (BOF) at Kashmere. The radio is used for real-time vehicle tracking, bus scheduling, and reporting bus emergencies. The CAD software at the BOF is used for updating schedule through real-time GPS information. Since METROLift is a ride-share service, METRO recommends passengers to anticipate a minimum one-hour travel time to their destination.

3.6 Emergency Management Services

Houston's geographic location and industrial infrastructure make it susceptible to both natural as well as industrial hazards. To counter any unforeseen challenge, the Office of Emergency

Management (OEM) located at TranStar houses the Harris County Office of Emergency Management and City of Houston Emergency Management Division that work independently pertinent to their jurisdictional boundaries.

However, during an emergency situation, the Emergency Operation Center (EOC) is activated at TranStar with appropriate city, county, state and federal agencies working collectively to respond quickly and efficiently to restore services to the people. The EOC constitutes officials from the Harris County Office of Emergency Management, City of Houston Emergency Management, Texas Department of Transportation, and METRO Police, and functions as the focal point for planning, advance information, and coordination of all support agencies and their activities for quick and effective response when activated. The EOC monitors weather conditions through local radars and freeway cameras, and renders real-time information via DMS signs and HAR. A mobile command post is currently under development. It will be used as a mobile center of operations at the site during major accidents or emergencies. This vehicle equipped with radio equipment, computers, telephones, computer systems, or other specialized equipment will act as an extension of the agencies to assist in the management of a major incident. Figure 3-6 illustrates the locations of the Harris County OEM flood sensors.

In addition to the environmental/flooding stations deployed by the county to monitor off-road water levels, TxDOT has deployed 38 sensors for monitoring roadway flood conditions throughout several counties in the region.

3.6.1 City of Houston Emergency Management Division

To address potential threats the Emergency Management Division (EMD) has developed a city emergency management plan. This plan provides the framework upon which the City of Houston plans for and responds to any natural or man-made disasters and emergencies. The plan encompasses four phases which are as follows:

- Mitigation – Activities that eliminate or reduce the probability of a disaster
- Preparedness – Activities developed to save lives and minimize damage
- Response – Actions that minimize loss of life and property damage
- Recovery – Short and long-term activities that restore city operations following the disaster/emergency

The EMD continually monitors local weather conditions through local radar, and local amateur radio operators via the Regional Skywarn Network. The EMD also coordinates with the Houston-Galveston Office of National Weather Service that monitors regional and national weather conditions and its impact on the city. In case of emergency situations, the EMD issues advance warnings and alerts to the public via the city municipal channel about the severity of the emergency and response and recovery underway.

The EMD also provides public education and training through combined practice exercises with city departments and outside agencies.

The City of Houston is currently developing an independent state of the art Emergency Center at Shepherd. This facility shall house personnel from the Emergency Management Division and Houston Police Department to improve detection, advance warning, and response to emergencies within the city.

3.6.2 Harris County Office of Emergency Management

Harris County is the third largest county in the United States spanning 1,788 square miles in area with a population of over three million people. The Harris County Office of Emergency Management (OEM) is responsible for emergency services before, during, and after natural or manmade disasters, which it shares with the 29 cities within Harris County. The OEM has developed and adopted a Basic Plan, called the Harris County Emergency Management Plan, which formulates all disaster operations of Harris County Departments and support agencies during emergencies. The OEM works in conjunction with the State, Federal and Local authorities, including the City of Houston and other municipalities in the surrounding Harris County during emergencies as a part of the EOC.

The OEM is responsible for planning the assembly of services, and preparation and distribution of information and procedures to the public through advisement and notification to ensure public safety and recovery during an emergency situation. In case of emergency situations, the HCOEM issues advance warnings and alerts to the public via the Media Alert Notification System (MANS). The MANS provides information regarding the severity of the emergency as well as the response and recovery underway through e-mails and a web page that citizens can access free of charge.

The OEM with assistance from the Texas Commission on Environmental Quality (TCEQ) analyzes the ozone information and immediately updates it on the web page free of charge to citizens. The OEM also manages flood and industrial information during an emergency. Flood information is gathered throughout the region by measuring stream levels at 125 detector stations. This information is shared in real time with the National Weather Service, and is used to issue advance warnings to the public concerning flood conditions throughout the region.

3.7 Commercial Vehicle Operations

Commercial vehicle operations (CVO) on Houston freeways have doubled over the past decade, attributed to industrial growth and increased shipping operations at the port of Houston. The increased truck operations have led to a significant increase in major accidents, especially truck rollovers at freeway-to-freeway interchanges. These accidents often lead to material spillage, roadway damage, and freeway closures for long periods. To avert such incidents, TxDOT has installed and is evaluating the Truck Rollover Warning System (TRWS). The intent of the application is to influence the commercial vehicle operator behavior and prevent excessive speeds on ramps that may result in rollovers at interchanges.

3.7.1 Truck Rollover Warning System

The truck rollover warning system (TRWS) is a coalition of vehicle classification and speed detection technologies, as well as warning mechanisms that is operated and maintained by TxDOT. Through extensive review and research of pertinent ITS technologies, in-pavement inductive loop detectors and a StreetCOM processor were selected as feasible equipment for vehicle classification and speed detection for TWRS. TxDOT has chosen fixed truck rollover warning signs with flashing beacons for advance warning to drivers regarding potential rollover problems at various freeway-to-freeway ramp interchanges in the region.

TWRS shall include on ramp vehicle classification and speed detection processing through a StreetCom processor housed in the traffic controller utilizing in-pavement inductive loop detector data. Flashing beacons on the truck rollover warning signs connected to the StreetCom processor will activate as commercial vehicle speeds on the ramps exceed the threshold speed for that specific ramp.

The truck rollover-warning device shall include fixed truck warning signs with flashing beacons at the top and bottom of the signs controlled via the StreetCOM processor in the controller cabinet. The proposed warning mechanism recommends application of an advanced curve and speed advisory sign at the entrance of the ramps followed by the fixed truck warning signs with flashing beacons connected to the traffic controller cabinet. A proposal for the replacement of existing advanced curve and speed advisory signs with a single steady flashing beacon with warning signs and truck rollover warning signs having two flashing beacons has also been recommended.

Currently, there are 12 TRWS deployment locations in the region. Figure 3-18 illustrates existing truck and ramp monitoring station locations in the Houston region.

3.8 Data Warehouse

A data warehouse has recently been developed for TranStar. This centralized data collection system houses data from multiple agencies and sources spanning across modal and jurisdictional boundaries. In addition, the process also enables information sharing and exchange through ITS Data Marts.

3.9 TxDOT Maintenance Management System

TxDOT has recently implemented an Integrated Maintenance Database Management System (IMDBMS) to track the maintenance needs of various ITS elements in the region as well as monitor equipment performance history. The IMDBMS is a map based maintenance management system with a database backend comprising detailed information for each component of the TranStar system. Originally conceived and deployed for the San Antonio TransGuide system on Unix based Sun Microsystems workstations using Sybase database, the system was ported to TranStar's Windows NT Oracle database system. A web browser provides the graphical user interface to the system allowing access from both within TranStar as well as from the field. The system enables maintenance staff and TranStar operators to view inventory, track equipment history, establish preventive maintenance schedules, generate work orders, and track life cycle equipment costs.

The maintenance database constitutes detailed information pertaining to each ITS element including equipment type, location (latitude and longitude coordinates for the GIS system), the vendor, the manufacturer, and contractor information. TransStar operators generate a work order request whenever a component is determined to have a problem. The work order comprising equipment information and the type of work is forwarded to the maintenance supervisor. The supervisor reviews the work order to schedule a date/time for the maintenance work and assigns field technicians for the work. Field technicians perform the necessary maintenance/on-site repairs to the system, and update the IMDBMS after work completion.

Figure 3-18: Existing TxDOT Truck Rollover Warning System Location

4.0 ITS REQUIREMENTS

ITS needs and requirements provide a foundation for the development of a regional ITS framework. Requirements gathered through interviews and discussion with the stakeholders provided the foundation to identify user needs and determine pertinent services desired. The interviews, workshops and focus group discussions helped create a requirements matrix, which contained information on the need, the associated stakeholders and the priority. This matrix was then compiled and sorted by priority. Most of the needs in the region were identified as high and medium priority. The needs were then classified into technical and institutional needs for mapping into user services and market packages. These needs reflect the perceptions of the stakeholders involved. This process is described in detail in the regional architecture document. This section describes the same set of potential user needs, problems, and issues that relate to the development, deployment, and operations of ITS implementations in the region sorted by functional areas.

4.1 Critical ITS Needs by Functional Area

4.1.1 Traffic Management

- **Alleviating Congestion:** The average Houston area commuter loses approximately 75 hours each year due to traffic related congestion.[1] According to the Texas Transportation Institute (TTI) data, approximately 40 percent of the peak period travel in the Houston-Galveston region occurred under extreme and severe congestion in 1999, a significant increase from the 26 percent experienced in 1982. Alleviating congestion is one of the major needs of region. Important priorities include reduction of single occupancy vehicle travel and reduction in vehicle miles traveled. The expressed need for alleviating congestion is the ability to monitor and manage the transportation system and to provide information to both the transportation providers and users seeking alternative routes, travel locations or travel modes.

- **Improve Capacity:** Construction costs and potential impacts increasingly limit the traditional approach for increasing capacity by building more lanes or roadways. While road building still remains an important priority, effective management of both transportation facilities and services is essential to maintaining system mobility, reliability, and recovery from traffic crashes, roadway repair, during special events or as a consequence of severe weather.

- **Enhance Incident Management:** The ability to identify and verify incidents on freeways and arterial streets is important. The approach to reacting to incidents can also be optimized by better coordination and technology including AVL and wireless communications for emergency vehicle notification. The management of special events is important. Early detection algorithm using AVI and VIVIDS, and GIS tools need to be developed and used to assist traffic operation personnel. The coverage area of incident management systems should continue to expand in the region.

[1] Texas Transportation Institute, Urban Mobility Report.

- **Optimize Signal Control:** There exists a need to improve signal synchronization and deploy a more traffic responsive/adaptive signal system in the region in order to provide true regional control and traffic optimization. The existing interconnected signal system (RCTSS) should continue to expand to include more intersections and jurisdictions. Also, sensors should be added to intersections to support more advanced strategies.

- **Implement Arterial Management:** Freeways have traditionally been the major area for ITS deployments and improvements. The stakeholders indicated the arterial system management, including using video cameras for traffic signal control, incident detection and monitoring, is a key requirement.

- **Demand Management:** The management of the HOV system to ease travel demand and increase safety is important. Currently, the HOV lane management is manual. These control systems need to be automated in the near future by developing a lane management plan and deploying the necessary equipment. Also, the coverage area of the HOV system should be extended.

- **Highway Rail Intersection Management:** Coordination is necessary with railroad companies to collect and share data on traffic and rail patterns. Grade crossing monitoring systems need to be installed and integrated with TranStar operations.

- **Interagency Coordination and Expansion:** The role of TranStar traffic management should be expanded to include communications and information sharing between adjacent jurisdictions. TranStar also needs to develop and maintain databases for planning, operations and evaluations. Increased coordination between adjacent jurisdictions is needed for incident and emergency management, special event management, traveler information and data archiving.

4.1.2 Traveler Information Services

There are various requirements associated with providing traveler information to the public in the areas of content, delivery methods and modes and are listed below:

Content: There exist various needs with respect to the content of the traveler information currently being provided in the region. These include:

- Developing a integrated traveler information database
- Improving the quality of enroute traveler information
- Provide access to real-time traveler information
- Use GIS based map information
- Provide parking availability information
- Disseminate information and data for visible benefits to incident management.
- Provide delay and arrival time information at transit park and ride locations and bus stops
- Provide trip itineraries to the public for trip planning and travel choices
- Provide alternate routes for travelers and transit

Delivery: The scope and the method of delivery for traveler information systems need to be expanded. Currently, the primary means of traveler information are the TranStar website and roadside devices such as HAR and DMS. New delivery methods and business models should be explored. The needs with respect to delivery of traveler information are listed below:

- Implement and promote the use of 511 as an outlet for information dissemination
- Expand the ability to have remote access through personal devices such as cell phone and PDA
- Provide information kiosks and video monitors
- Continue DMS expansion
- Install DMS on arterial to support traffic operations and to support special events.

4.1.3 Public Transportation Management

One of the goals is to plan, develop and implement a comprehensive regional transit system that will improve the mobility options and provide better connectivity between the urban, suburban and rural areas of the region. It is also vital that continued growth in vehicular travel be slowed by encouraging greater use of mass transit, ridesharing, vanpooling, tele-working and other demand-management programs. Some of the major needs for the Public Transportation Management functional area are:

- **Improve Mobility and Access:** There are few public transportation services outside of the METRO service area. A large portion of the eight county region's population resides outside of areas with scheduled transit services. Rapid transit and corridor planning are two important approaches to explore to increase mobility and fill the transportation gaps in the region.

- **Develop Public Transportation Management Strategies:** The transportation choices for these populations should be improved. New technologies and software must be investigated to monitor vehicle system parameters such as engine temperature and integrate this information with an automated maintenance scheduling system. Ridership data and other data for transit route planning purposes is also critical to the development of accurate and reliable schedules and providing more efficient service.

- **Advanced Transit Vehicle Systems:** The use of Automatic Vehicle Location systems needs to be expanded to monitor transit vehicles and provide traveler information. Advanced collision warning technologies like lateral and longitudinal collision warning should be investigated. The "Smart bus" concept as part of the IVOMS project is a step in this direction.

- **Improve Transit Traveler Information:** Improving transit traveler information by providing real time information is critical. This includes development of arrival time algorithms, deployment of message signs and kiosks at bus stops, and development of Internet applications for METRO.

4.1.4 Emergency Management

Emergency management is of critical importance to the region. Needs for emergency management include:

- **Enhance Interagency Coordination:** A communications system is required detailing the method and the protocol for interagency coordination during emergencies. Telephone systems can be the primary link with wireless technologies and high-speed cable connections as future implementations. A regional emergency management plan needs to be developed. The sharing of data between agencies should be encouraged.

- **Improve Traffic Coordination:** Emergency Management centers should have the ability to obtain and use traffic data from TranStar for evacuation routing and planning.

- **Faster Emergency Notification:** Better information needs to be provided to the public during emergencies. Warnings for floods and hurricanes should also be improved both in terms of monitoring and method of dissemination. The use of roadside ITS systems during emergencies should be enhanced.

- **Expand Flood Monitoring:** There is a need to improve flood-monitoring sensors on arterials and link the system to TranStar. Weather information systems and monitoring devices are necessary to generate advance warnings to the public.

4.1.5 Electronic Payment

Increasing the use of Electronic payment systems is vital to the region. The needs for the functional area are:

- **Expansion of Electronic Payment Methods:** Existing facilities for electronic payment have to be expanded and integrated. Harris County Toll Road Authority (HCTRA) would like to increase the percentage of traffic using the EZ-PASS system. EZ-PASS tags should be made more readily available. HCTRA would also like to increase the operating area to include adjacent counties.

- **Multi-modal Integration:** Multi-modal coordination is required to combine tolls, transit fare payments, parking and other services. This is currently under investigation in other areas of the country and should be monitored with respect to application in Houston.

- **Improve Toll Plaza Monitoring and Enforcement:** Remote toll plazas should be equipped with automated systems to reduce staff requirements. CCTV and VIDS should be installed on approaches to the toll plazas to monitor traffic congestion and modify toll collection strategies to minimize delay.

- **Electronic Passenger Fare Collection:** METRO should investigate the use of smart cards for fare management.

4.1.6 Commercial Vehicle Management

Commercial vehicle management is essential in this region with considerable truck traffic. The needs for this area are:

- **Improve Safety:** The safety and management of commercial vehicles is an important concern in the area with considerable truck traffic. The needs include truck rollover warning devices, on board safety monitoring and vehicle safety inspections. HAZMAT incident management strategies should be improved.

- **Commercial Vehicle Management:** Improvements in signage for routing commercial vehicles are needed. CB Wizard (a system to provide work zone information to truckers on Citizen Band radio) and Weigh-in-Motion stations should be deployed. Other moderate requirements include dedicated truck lanes, on-board information, routing for over-sized trucks and automatic enforcement of commercial vehicle regulations.

4.1.7 Vehicle Safety

Vehicle safety monitoring systems and accident reporting and analysis tools should be developed to meet long term safety needs.

- **Conduct Research:** Research is necessary to monitor and identify causes of crashes in the region and to develop appropriate technology. Lateral and Longitudinal collision systems, truck rollover collision systems, advanced highway rail intersections etc., must be investigated and deployed.

4.1.8 Emissions Management

Air quality compliance goals are particularly challenging as the vehicle miles of travel are expected to increase 36 percent between 1993 and the 2007, the air quality attainment year. The expressed need is to improve sensor testing and operational policies for emissions management and testing.

4.1.9 Archived Data Management

The region should expand the ability of the systems to monitor and collect transportation data. Also, the data warehousing and the institutional arrangements required need to be explored for applications in transportation planning, transit planning etc. It is recognized that there are current efforts underway in the area of data warehousing.

4.1.10 Safety and Security[1]

Many roads in the region are hazardous and prone to a high number of vehicle crashes. These crashes create human costs to those involved and traffic costs to the whole region by increasing the costs of incident management, road repair, and insurance costs. Two significant safety issues are the frequency of crashes involving trains and motor vehicles traversing at grade rail crossings and traffic fatalities involving commercial trucks. Improving safety for pedestrians and bicyclists is also a high priority. There is a need to improve security on the system through the

[1] From the HGAC 2022 Transportation Plan

protection of facilities (e.g. airports, bridges, underpasses), the safe transportation of hazardous materials, the ability to move people quickly during an emergency evacuation, and the general protection of drivers and pedestrians in all modes of transportation. The security of these national assets from acts of terrorism must be a continued high priority. Transportation applications to homeland security must be explored and first responders should be trained to react to hostile situations.

4.1.11 Maintenance and Construction Management

There is a strong need to manage traffic better and provide better information to users about construction and work zones. This has been recognized nationally and has led to the development of a new user service "maintenance and construction operations" in the national ITS architecture. The region needs to develop smart work zone strategies involving increased coordination with other agencies and remote monitoring of work sites. Notification about planned construction and maintenance activities should also be disseminated through the existing traveler information infrastructure.

4.1.12 Other Requirements

In addition to the needs by functional area, institutional needs and requirements are extremely important. While the system architecture document provides a detailed listing of the region's institutional needs, a brief listing of these general needs is given here for the sake of completeness.

- Agency coordination was mentioned as the critical need influencing the success of ITS deployments. All the stakeholders were interested in improving communications between the various centers in the region.
- The breaking down of institutional barriers is another essential need.
- Creative funding opportunities should be explored for ITS deployment.
- Existing ITS deployments must be leveraged and maximum benefit must be gleaned.
- The region needs to develop a skilled ITS workforce in the region.
- Public involvement must be encouraged and sought for ITS.

5.0 THEMES, TRENDS, AND STRATEGIES

As ITS is deployed within a region, becomes more mainstream nationally, and technology advances, some observations can be made with respect to development, deployment, and operation of these advanced systems. This chapter will explore a variety of topics and provide some insight and direction to assist agencies in maximizing the benefits of ITS technologies.

Themes identify and underscore the various underlying processes and activities that are vital during the development and implementation of a regional ITS system. They explicate methodologies required to accomplish the vision, goals and objectives in view of the escalating needs and socio-economic challenges. Trends symbolize recurring themes as observed during the development of the requirements model based upon user input on system needs, issues, and problems.

Strategies reflect upon the approach agencies should pursue to counter user needs, problems, and issues through selection of ITS user services and tools to maximize safety and efficiency of the transportation system.

The following guiding principles characterize ITS strategies and themes/trends that need to be incorporated into existing agency policies and procedures to facilitate operations and management of the integrated Houston ITS system.

5.1 Institutional Coordination

Coordination is an integral part of many regional ITS strategies. Increasingly, transportation organizations around the country, and in the Houston region, have partnered together in applying advanced technologies to manage transportation facilities and services. Continued and enhanced coordination is critical to realization of the full potential of the Houston region ITS program. Chapter 6 discusses Houston region agency ITS roles and coordination strategies.

5.2 Integration and Information Sharing

Integration symbolizes reliance and data or information exchange within and between ITS subsystems that is key to the overall functionality of an integrated ITS system. Level of integration, however, is driven by several factors including, age of systems, cost, benefit, and functional dependencies. For example, the traffic conditions in Houston might not be directly relevant to day-to-day traffic management operations outside the Houston metropolitan area. Therefore, sharing control of field devices such as traffic signal, closed-circuit television (CCTV) cameras in Houston (which requires large communication bandwidth) might not be a need for rural jurisdictions. On the other hand, TxDOT CCTV cameras located at rural interchanges may be of use to local jurisdictions for traffic monitoring purposes. In general, level of integration can be classified into 3 levels:

- Level I Peaceful Co-existence
- Level II Information Sharing but No Dependency
- Level III Information Sharing with Dependency

Level I, Peaceful Co-existence, involves no physical integrations between ITS sub systems. Information exchange takes place in the form of coordination typically based on requests via meetings or public communications media such as telephone, fax, e-mail, etc. Arguably, such institutional coordination is the basis of further integration of ITS systems.

Level II, Information Sharing but No Dependency, represents some level of physical integration among the ITS subsystems. Data networking (e.g., direct connection, modem, wide-area-network, internet) is involved to provide electronic data exchange among the ITS subsystems. The typical data sharing scheme is to periodically push (e.g., using File Transfer Protocol (FTP)) a copy of the selected system (e.g., signal timing plans) or operation data (e.g., traffic volumes, speeds, incidents) to a remote system. However, the data exchange does not affect the actual functionalities of the ITS subsystems. That is, no dependency exists that could adversely affect the operations of other ITS subsystems.

Level III, Information Sharing with Dependency, represents the highest level of integration which ITS subsystems share the common communications network, data servers, and control over the field devices. Often, the functionalities of a subsystem rely on data input or sharing of physical components (e.g., communication lines) from other subsystems. Dependency exists among the subsystems. The failure of a subsystem could adversely affect the functions and performance of other subsystems. The advantage of a fully integrated system is the provision of ultimate flexibility and efficiency of data and device control sharing. However, reliability and survivability are critical when the dependency between subsystems exists. It is important to identify the critical path and provide adequate redundancy to the critical components.

For the eight county region, ITS integration could take form in all three levels depending on the systems involved. The adequate level of integration for overall and different ITS services will be determined by a number of factors, including functional needs, cost, and respective jurisdictions' decisions. Analysis should be performed to determine the level of integration based on functional needs, resource requirements, and jurisdictional constraints. A phased approach should be considered in planning and implementation of an integrated regional ITS system.

5.3 Use of Standards for Data Collection, Format, and Exchange

Standards are fundamental to the establishment of nationally compatible and interoperable ITS systems and will enable deployment of consistent, non-interfering, reliable systems on local, regional and national levels. Implementing standards early in the deployment process of specific ITS systems provides various benefits including:

- National Compatibility providing the ability to use the same equipment and services, regardless of the geographical location. The architecture identifies roughly 45 specific interfaces requiring nationwide compatibility.

- Multiple Suppliers can encourage competition in the delivery of ITS services through the implementation of standards in areas where a standard is not necessarily required to provide a traveler with seamless operation of his ITS service. These interfaces will benefit from standards in allowing multiple suppliers of equipment and software that will directly connect to other ITS systems.

- Ranges of Functionality – The standard packages contain data flows that support several levels of service. For example, the *trip plan* data flow contains a large number of optional data fields. The standards developer is encouraged to maintain the flexibility in the data flow specifications to allow for multiple implementations.

- Synergy – The architecture begins with a logical architecture that satisfies the identified user services. As a result, there are functions and data flows common to several of the services. These "processes" appear in several higher level data flows and, because they come from a single source, support synergy and consistency.

- Risk Reduction – The architecture reduces risk to public providers, private providers and consumers. For public providers, existence of standards means that equipment purchased one year will be likely to operate with new equipment purchased several years from now. This also means that agencies will not be locked into specific vendors (proprietary systems) since all vendors will be able to build to the same standard (open architecture). For private providers, existence of standards means that they can gather information from multiple sources using well defined message sets and thereby increases the level of service to their customers (economies of scale). For consumers, products built to a particular standard will allow a user to select their service provider from a number of companies (competition), not just the company that their equipment happens to be compatible with.

5.3.1 Identification of Relevant Standards for the Houston Region

Approximately eighty (80) different ITS standards have been identified as relevant in the implementation of the systems in the National ITS Architecture. The task of working with the public and private sector ITS community to develop, educate and outreach these standards has been tasked to seven different standards development organizations (SDOs). These SDOs are:

- American Association of State Highway and Transportation Officials (AASHTO)
- American National Standards Institute (ANSI)
- American Society for Testing and Materials (ASTM)
- Institute of Electrical and Electronics Engineers (IEEE)
- Institute of Transportation Engineers (ITE)
- National Electrical Manufacturers Association (NEMA)
- Society of Automotive Engineers (SAE)
- Standards that apply specifically for traffic and transit management applications are jointly developed by ITE, NEMA and AASHTO under a joint committee known as the National Transportation Communications for ITS Protocol (NTCIP) Committee.

The system architecture defined for the Houston region (separate document) included the physical architecture outlining systems and subsystems that are applicable for the region. To perform certain functions, these systems need to communicate with each other. These communication links in the Physical Architecture are defined by the architecture flows between the subsystems. The architecture flows (identified in the Houston Region System Architecture) are the pieces that identify the standards and define how the communications take place between the various subsystems in the National ITS Architecture.

Recently the U.S. DOT's Joint Program Office (JPO) has placed a major emphasis on defining these standards based on application areas grouped by the National ITS Architecture interfaces (e.g., center to center, center to roadside), which are deployment oriented and define specific ITS services or systems. The application areas enable a deployment perspective to grouping the available 80 ITS Standards.

To identify applicable standards for the Houston region, the application areas based on the National ITS Architecture Interfaces were reviewed and compared to the Houston Region System Architecture. This review enabled the identification of relevant application areas, National ITS Architecture interfaces, and standards for the Houston region. Table 5-1 lists all the application areas, the National ITS Architecture Interfaces and all the standards. All the standards identified in the table are applicable to the Houston Region as the region has a wide variety of existing and planned ITS applications (with TranStar operative and being part of the region).

Definitions of the application areas and interfaces are available on the standards web site (http://www.its-standards.net).

5.4 System Redundancy and Survivability

This section discusses critical areas to system operations to ensure reliability of ITS deployments in terms of risks and system efficiency during unanticipated emergency conditions and situations.

As the ITS operations reliance on communications and computer systems has increased, so too has the need for increased availability of those systems. System malfunctions due to hardware and/or software failures or natural or man-made disasters could cause disruptions in ITS services. Redundancy is needed for critical system components. Systematic data backup and archiving are necessary. Creating extensive redundancy in any system can increase that system's availability. However, the cost to do so can be significant. For ITS systems, priority should be given to the critical and public safety related operations. For less critical ITS operations, full redundancy may not be a requirement. However, it is important to develop backup procedures as a fallback position in the case of system failure.

The first step for any ITS system is to determine and quantify two critical issues: the probability that a system will fail and the consequences that this poses to the operations. Consider the number of components in the system and identify any Single Points of Failure (SPOFs). It is also important to examine the possible system breakdown scenarios based on natural and man-made disasters. For ITS system components such as power supplies, major communication infrastructure and critical computer data servers, redundant system should be considered in the system architecture design. In the case of data server, redundancy typically involves real-time mirroring of processes and the database. Should a component failure occur, the redundant system can take over in no time to avoid service disruption.

Table 5-1: Relevant Standards for the Houston Region (by Application Area and National ITS Architecture Interfaces)

		Center to Center						Center to Roadside							Center to Vehicle/ Traveler			Roadside to Roadside	Roadside to Vehicle	
Document Number[1]	**Document Name**	Data Archival	Incident Management	Rail Coordination	Traffic Management	Transit Management	Traveler Information	Data Collection/	Dynamic Message Signs	Environmental Monitoring	Ramp Metering	Traffic Signals	Vehicle Sensors	Video Surveillance	Mayday	Transit Vehicle Communicatio	Traveler Information	HRI	Signal Priority	Toll/Fee Collection
ANSI TS285	Commercial Vehicle Safety and Credentials Information Exchange	Æ																		
ANSI TS 286	Commercial Vehicle Credentials	Æ																		
ASTM AG	ADMS Standard Guidelines	Æ																		
ASTM DD	ADMS Data Dictionary	Æ																		
ASTM N/A	Standard Specification for 5.9 Ghz Data Link Layer																		Æ	Æ
ASTM N/A	Standard Specification for 5.9 Ghz Physical Layer																		Æ	Æ
ASTM PS 105-99	Specification for Dedicated Short Range Communication (DSRC) Data Link Layer: Medium Access and Logical Link Control																		Æ	Æ
ASTM PS 111-98	Specification for Dedicated Short Range Communication (DSRC) Physical Layer using Microwave in the 902-928 MHz																		Æ	Æ
CEA/EIA-794	Data Radio Channel (DARC) System																Æ			
CEA/EIA-795	Subcarrier Traffic Information Channel (STIC) System																Æ			
IEEE P1512-2000	Standard for Common Incident Management Message Sets (IMMS) for use by EMC's	Æ	Æ																	

[1] The documents may be obtained from the standards development organizations. The U.S. DOT standards website (http://www.its-standards.net) includes links to these sites in the "web links" portion of the site.

Table 5-1: Relevant Standards for the Houston Region (by Application Area and National ITS Architecture Interfaces) (Continued)

		Center to Center						Center to Roadside							Center to Vehicle/ Traveler			Roadside to Roadside	Roadside to Vehicle	
Document Number[1]	**Document Name**	Data Archival	Incident Management	Rail Coordination	Traffic Management	Transit Management	Traveler Information	Data Collection/	Dynamic Message Signs	Environmental Monitoring	Ramp Metering	Traffic Signals	Vehicle Sensors	Video Surveillance	Mayday	Transit Vehicle Communicatio	Traveler Information	HRI	Signal Priority	Toll/Fee Collection
IEEE P1512.1	Standard for Traffic Incident Management Message Sets for use by EMC's		Æ		Æ															
IEEE P1512.2	Standard for Public Safety IMMS for use by EMCs		Æ																	
IEEE P1512.3	Standard for Hazardous Material IMMS for use by EMCs		Æ																	
1EEE P1512.a	Standard for Emergency Management Data Dictionary	Æ	Æ		Æ															
IEEE P1556	Security /Privacy of Vehicle/RS Communications Including Smart Card Communications																			Æ
IEEE P1570	Standard for Interface Between the Rail Subsystem and the Highway Subsystem at a Highway Rail Intersection																		Æ	
IEEE Std 1455-1999	Standard for Message Sets for Vehicle/Roadside Communications																	Æ		
ITE TM 1.03	Standard for Functional Level Traffic Management data Dictionary (TMDD)	Æ	Æ		Æ	Æ	Æ													Æ
ITE TM 2.01	Message Sets for External TMC Communication (MS/ETMCC)	Æ	Æ		Æ	Æ	Æ													
ITE TS 3.TM	TCIP-Traffic Management™ Business Area Standard					Æ														
NTCIP 1101	Simple Transportation Management Framework (STMF)							Æ	Æ	Æ	Æ	Æ	Æ	Æ						
NTCIP 1102	Base Standard: Octet Encoding Rules (OER)	Æ	Æ	Æ	Æ	Æ	Æ	Æ	Æ	Æ	Æ	Æ	Æ	Æ						

Table 5-1: Relevant Standards for the Houston Region (by Application Area and National ITS Architecture Interfaces) (Continued)

		Center to Center						Center to Roadside							Vehicle/ Traveler			Roadside to Roadside	Roadside to Vehicle	
Document Number[1]	Document Name	Data Archival	Incident Management	Rail Coordination	Traffic Management	Transit Management	Traveler Information	Data Collection/	Dynamic Message Signs	Environmental Monitoring	Ramp Metering	Traffic Signals	Vehicle Sensors	Video Surveillance	Mayday	Transit Vehicle Communicatio	Traveler Information	HRI	Signal Priority	Toll/Fee Collection
NTCIP 1103	Simple Transportation Management Protocol (STMP)							Æ	Æ	Æ	Æ	Æ	Æ	Æ						
NTCIP 1201	Global Object Definitions							Æ	Æ	Æ	Æ	Æ	Æ	Æ			Æ			
NTCIP 1202	Object Definitions for Actuated Traffic Signal Controllers											Æ								
NTCIP 1203	Object Definitions for Dynamic Message Signs								Æ											
NTCIP 1204	Object Definitions for Environmental Sensor Stations and Roadside Weather Information Systems							Æ		Æ										
NTCIP 1205	Data Dictionary for Closed Circuit Television (CCTV)							Æ					Æ	Æ			Æ			
NTCIP 1206	Data Collection and Monitoring Devices							Æ		Æ			Æ							
NTCIP 1207	Ramp Meter Controller Objects										Æ									
NTCIP 1208	Object Definitions for Video Switches							Æ					Æ	Æ			Æ			
NTCIP 1209	Transportation System Sensor Objects							Æ		Æ			Æ							
NTCIP 1210	Objects for Signal Systems Master				Æ							Æ								
NTCIP 1211	Objects for Signal Control Priority																		Æ	
NTCIP 1301	Message Set for Weather Reports		Æ		Æ	Æ	Æ													
NTCIP 1401	TCIP – Common Public Transportation (CPT) Business Standard	Æ	Æ			Æ	Æ									Æ	Æ			

Table 5-1: Relevant Standards for the Houston Region (by Application Area and National ITS Architecture Interfaces) (Continued)

		Center to Center						Center to Roadside							Center to Vehicle/ Traveler			Roadside to Roadside	Roadside to Vehicle	
Document Number[1]	Document Name	Data Archival	Incident Management	Rail Coordination	Traffic Management	Transit Management	Traveler Information	Data Collection/	Dynamic Message Signs	Environmental Monitoring	Ramp Metering	Traffic Signals	Vehicle Sensors	Video Surveillance	Mayday	Transit Vehicle Communicatio	Traveler Information	HRI	Signal Priority	Toll/Fee Collection
NTCIP 1402	TCIP – Incident Management (IM) Business Area Standard		Æ			Æ										Æ	Æ			
NTCIP 1403	TCIP – Passenger Information (PI) Business Area Standard	Æ				Æ	Æ									Æ	Æ			
NTCIP 1404	TCIP – Scheduling/Runcutting (SCH) Business Area Standard					Æ	Æ									Æ				
NTCIP 1405	TCIP – Spatial Representation (SP) Business Area Standard		Æ			Æ	Æ									Æ	Æ			
NTCIP 1406	TCIP – Onboard (OB) Business Area Standard	Æ														Æ	Æ			
NTCIP 1407	TCIP – Control Center (CC) Business Area Standard	Æ				Æ										Æ				
NTCIP 1408	TCIP – Fare Collection (FC) Business Area Standard	Æ				Æ										Æ	Æ			
NTCIP 2001	Class B Profile							Æ	Æ	Æ	Æ	Æ	Æ	Æ						
NTCIP 2101	Point to Multi-Point Protocol Using RS-232 Subnetwork Profile							Æ	Æ	Æ	Æ	Æ	Æ	Æ						
NTCIP 2102	Subnet Profile for PMPP Over FSK Modems							Æ	Æ	Æ	Æ	Æ	Æ	Æ						
NTCIP 2103	Subnet Profile for Point-to-Point Protocol Using RS-232							Æ	Æ	Æ	Æ	Æ	Æ	Æ						
NTCIP 2104	Subnet Profile for Ethernet	Æ	Æ	Æ	Æ	Æ	Æ	Æ	Æ	Æ	Æ	Æ	Æ	Æ						
NTCIP 2201	Transportation Transport Profile							Æ	Æ	Æ	Æ	Æ	Æ	Æ						
NTCIP 2202	Internet (TCP/IP and UDP/IP) Transport Profile	Æ	Æ	Æ	Æ	Æ	Æ	Æ	Æ	Æ	Æ	Æ	Æ	Æ						
NTCIP 2301	Application Profile for Simple Transportation Management Framework (STMF)							Æ	Æ	Æ	Æ	Æ	Æ	Æ						

Table 5-1: Relevant Standards for the Houston Region (by Application Area and National ITS Architecture Interfaces) (Continued)

		Center to Center						Center to Roadside							Center to Vehicle/ Traveler			Roadside to Roadside	Roadside to Vehicle	
Document Number[1]	Document Name	Data Archival	Incident Management	Rail Coordination	Traffic Management	Transit Management	Traveler Information	Data Collection/	Dynamic Message Signs	Environmental Monitoring	Ramp Metering	Traffic Signals	Vehicle Sensors	Video Surveillance	Mayday	Transit Vehicle Communicatio	Traveler Information	HRI	Signal Priority	Toll/Fee Collection
NTCIP 2302	Application Profile for Trivial File Transfer Protocol							Æ		Æ			Æ	Æ						
NTCIP 2303	Application Profile for File Transfer Protocol (FTP)	Æ	Æ	Æ	Æ	Æ	Æ	Æ	Æ	Æ			Æ	Æ						
NTCIP 2304	Application Profile for Data Exchange ASN.1 (DATEX)	Æ	Æ	Æ	Æ	Æ	Æ													
NTCIP 2305	Application Profile for Common Object Request Broker Architecture (CORBA)	Æ	Æ	Æ	Æ	Æ	Æ													
NTCIP 2501	Information Profile for DATEX	Æ	Æ	Æ	Æ	Æ	Æ													
NTCIP 2502	Information Profile for CORBA	Æ	Æ	Æ	Æ	Æ	Æ													
SAE J1746	ISP-Vehicle Location Referencing Standard																Æ			
SAE J2313	On-board Land Vehicle Mayday Reporting Interface														Æ					
SAE J2353	Data Dictionary for Advanced Traveler Information Systems (ATIS)	Æ			Æ	Æ	Æ									Æ	Æ			
SAE J2354	Message Set for Advanced Traveler Information System (ATIS)	Æ			Æ	Æ	Æ									Æ	Æ			
SAE J2369	Standard for ATIS Message Sets Delivered over Bandwidth Restricted Media																Æ			
SAE J2529	Rules for Standardizing Street Names and Route Ids	Æ			Æ	Æ	Æ									Æ	Æ			
SAE J2540	Messages for Handling Strings and Look-up Tables in ATIS Standards	Æ			Æ	Æ	Æ													

Table 5-1: Relevant Standards for the Houston Region (by Application Area and National ITS Architecture Interfaces) (Continued)

Document Number[1]	Document Name	Center to Center (Data Archival; Incident Management; Rail Coordination; Traffic Management; Transit Management; Traveler Information)	Center to Roadside (Data Collection/; Dynamic Message Signs; Environmental Monitoring; Ramp Metering; Traffic Signals; Vehicle Sensors; Video Surveillance)	Center to Vehicle/ Traveler (Mayday; Transit Vehicle Communicatio; Traveler Information)	Roadside to Roadside (HRI)	Roadside to Vehicle (Signal Priority; Toll/Fee Collection)
Foundation and General Standards Documents						
IEEE Std 1488-2000	Trial-Use Standard for Message Set Template for Intelligent Transportation Systems	Æ	Æ	Æ	Æ	Æ
IEEE Std 1489-1999	Standard for Data Dictionaries for Intelligent Transportation Systems	Æ	Æ	Æ	Æ	Æ
ITE 9603-1	ATC Application Program Interface (API)		Æ			
ITE 9603-2	ATC Cabinet		Æ			
ITE 9603-3	Advanced Transportation Cabinet (ATC)		Æ			
NTCIP 1104	CORBA Naming Convention	Æ				
NTCIP 1105	CORBA Security Service	Æ				
NTCIP 1106	CORBA Near-Real Time Data Service	Æ				
NTCIP 1400	TCIP- Framework Document	Æ		Æ		
NTCIP 8003	Profiles – Framework and Classification of Profiles	Æ	Æ			
SAE J2374	National Referencing Information Report	Æ	Æ	Æ		

The following standards are not included in Table 5-1 due to the reasons stated below:

- They are mapped to the National ITS Architecture, but do not fall under any of the application areas stated above.
- They are not mapped to the National ITS Architecture.

Document Number	Document Name
ANSI TS 284	Commercial Vehicle Safety Reports
IEEE Bk. 1-6: SH94633-SH 94638	Survey and Analysis of Existing Standards and Communication Technologies
IEEE P1454	Recommended Practice of the Selection and Installation of Fiber Optic Cable
NTCIP 9001	NTCIP Guide
SAE J1663	Truth-in Labeling Standard for Navigation Map Databases
SAE J1708	Serial Data Communication Between MicroComputer Systems in Heavy-Duty Vehicle
SAE J1760	ITS Data Bus Security Services Recommended Practice
SAE J1761	Information Report on ITS Terms and Definitions
SAE J1763	A Conceptual ITS Architecture: An ATIS Perspective
SAE J2256	In-Vehicle Navigation System Communication Device Message Set Information
SAE J2352	Mayday Industry Survey Information Report
SAE J2355	ITS Data Bus Architecture Reference Model Information Report
SAE J2364	Standard for Navigation and Route Guidance Function Accessibility While Driving
SAE J2366-1	ITS Data Bus Protocol – Physical Layer Recommended Practice
SAE J2366-2	ITS Data Bus Protocol – Link Layer Recommended Practice
SAE J2366-4	ITS Data Bus Protocol – Thin Transport Layer Recommended Practice
SAE J2366-7	ITS Data Bus Protocol – Application Layer Recommended Practice
SAE J2367	ITS Data Bus Gateway Recommended Practice
SAE J2372	Field Test Analysis Information Report
SAE J2373	Stakeholder's Workshop Information Report
SAE J2395	ITS In-Vehicle Message Priority
SAE J2396	Measurement of Driver Visual Behavior Using Video Based Methods
SAE J2399	Adaptive Cruise Control: Operating Characteristics and User Interface
SAE J2400	Forward Collision Warning: Operating Characteristics and User Interface
SAE J2539	Comparison of GATS Messages to SAE ATIS Standards Information Report

For all ITS systems/operations, backup procedures should be developed in the case of unexpected system breakdown. The backup procedures may involve from the use of alternative communications to paper and pencil manual operations. Possible scenarios need to be identified, examined and rehearsed. Necessary institutional coordination needs to be established as well. The events following Tropical Storm Allison sheds light directly on this topic and it is recognized that since then several efforts have been undertaken to improve system redundancy and institutional coordination.

5.5 System Expandability and Migration

The concepts of system expandability and migration are important in preserving the investment of existing and future ITS systems. For the eight county region, it is logical to expand the ITS infrastructure based on the existing TranStar architecture. The basic philosophy is not to replicate Houston TranStar in the eight county region, rather, utilize Houston TranStar and potentially other centers as hubs to facilitate important functions such as data exchange, archive, operations, and coordination.

5.5.1 Communication Systems

Communication systems are the key to an integrated regional ITS system. Houston TranStar currently uses an extensive fiber optics network along the major freeways in the Houston metropolitan area to facilitate traffic monitoring and management functions using closed-circuit-television cameras, traffic sensors, variable message signs, etc. It is logical to share the large data bandwidth and the existing networking equipment with jurisdictions along the instrumented freeways. However, systematic expansion of the fiber network to the eight county region is cost prohibitive due to the large geographic area. A possible solution is the partnership with private communication service providers. The public provides the right of way for fiber conduit in exchange for data bandwidth – a plausible model that has been widely adopted all over the country. In addition, point-to-point wireless communications (e.g., microwave, spread spectrum) may also be used to connect the geographically diverted ITS subsystems.

5.5.2 Data Network

Many ITS functions for the eight county region involve electronic data exchange and archiving. It is logical to use the well-established TranStar infrastructure to facilitate the various wide area data networking (e.g., device control sharing, data dissemination) and archiving (e.g., ITS data warehouse) functions required by the integrated ITS system. This requires the expansion of existing TranStar communication, networking, and data storage capacities in support of the ITS subsystems throughout the eight county region.

5.5.3 Migration Strategy

The advent of computer and micro electronics has greatly reduced the life cycle of today's ITS systems. It is important to take account of future migration and expansion in the system planning and design. For example, modular system design that uses matured and well-adopted interface (e.g., XML) allows incremental upgrade of system components and thus reduces the high cost of replacing the entire system. In addition, the use of ITS Standards allows interoperability between different products and thus reduces the risk and cost of replacing and upgrading ITS system components. A regional guideline needs to be established to provide guidance in ITS system procurement.

5.6 Areas for Public and Private Partnership

In the early days of the Federal ITS program, the potential for partnerships in ITS deployment were much heralded, both in terms of public-private and public-public partnerships. In terms of private sector partnerships, the logic was that, in addition to the broader trend toward increasing privatization of certain transportation functions, ITS projects were especially enticing because of the opportunities for companies to test new technologies and gain access to new markets, especially in regard to traveler information. Public-public partnerships were considered promising given the multi-jurisdictional nature of many ITS strategies, and because partnerships provide the opportunity to pool limited resources and share knowledge and risk.

Based on the last 10 years of national ITS experience, the following conclusions can be drawn relative to ITS partnerships:

- Successful private-public partnerships are possible, and should be pursued, but are not necessarily plentiful or “easy”—great care must be taken in structuring the partnership so that all partners are provided returns in proportion to their risks and costs, and there is very little “low hanging fruit”, developing a successful partnership takes effort.

- Public-public partnerships are a highly effective way to coordinate efforts, share risks and stretch limited resources.

- Partnership success is not so much a function of the type of ITS activity being pursued—there are few if any ITS project types that are guaranteed “no brainer” partnership winners—but rather a function of the creativity and forethought of project proponents in establishing the basic project concept and structure, from its inception, in such a way as to provide partnership opportunities.

- A clear definition of the desired “ends”, coupled with flexibility on the “means” is critical to attracting the private sector. If the public partner focuses on desired outcomes, and is willing to let the partnership dictate, to some extent, the specific delivery mechanisms, almost any type of ITS project can be structured in such a way as to attract a private partner.

- Although private partners typically demand flexibility on ***how*** they deliver their side of the bargain, they need specifics regarding the desired outcome. They are creative in determining how to do something, but they are not necessarily imaginative in deciding what should be done. Broad, open-ended solicitations for private partners—the “here’s our plan, let us know if you see anything you want to participate in” approach, are not often successful.

Table 5-2 lists some of the ITS activities that generally represent good partnership candidates. However, as noted above, partnerships are as much about a way of thinking and effort as they are about project types, and project sponsors are encouraged to give partnership possibilities serious consideration during the earliest stages of project development, and to be prepared to let partnership considerations shape the project.

Table 5-2: ITS Partnership Candidates

Public-Private Partnerships	Public-Public Partnerships
Partnership with communications companies to trade access to public right-of-way in exchange for communication services.	Coordinated implementation and operation of traffic and incident management systems at border areas (e.g., city-city and city-county borders), including coordinated traffic signals.
Partnership with cellular telephone service providers to facilitate statewide use of a common cellular number to report incidents (e.g., *999).	Partnerships among different emergency service providers to implement emergency vehicle traffic signal priority.
Partnership with commercial organizations to compliment MAP coverage (private companies may provide the service for free, financing their efforts through advertising on the side of their vehicles).	Partnerships between TxDOT and local jurisdictions to plan and implement freeway traffic diversions.
Partnership with commercial traveler information services to facilitate two-way sharing of information.	Partnership among emergency services providers in implementing integrated communications systems.
Partnership with cable television stations for traveler information dissemination.	Partnerships among governmental agencies in sharing communications resources (e.g., shared radio system).
Partnership with telephone companies for traveler information dissemination.	
Partnership with local industries and Chambers of Commerce to facilitate the deployment of traveler information kiosks as well as travel services such as "yellow page", hotel reservations, etc.	
Technology demonstrations, especially smaller scale, non-Federally funded ones where there is more flexibility.	

5.7 Leveraging Funds for Homeland Security

In the wake of September 11, 2002, there is a heightened awareness of transportation safety and security issues. These issues include transportation assets as the targets or means for terrorism, and the ability of emergency responders and transportation agencies to work together to coordinate the transportation components of incident response, public evacuation.

Many transportation security strategies rely upon the infrastructure and institutional arrangements associated with ITS, including traffic management and traveler information systems—there is a natural link and overlap between transportation security efforts and ITS. ITS America has summarized many of the transportation security linkages to ITS. This information appears in Table 5-3. Given the strong linkage between ITS and transportation security, the increased national focus and associated funding priority that has been placed on transportation security creates opportunities for accelerating the implementation of many ITS projects.

Table 5-3: ITS Homeland Security Applications

ITS Application	Description
Pre-Event Applications (Detection & Planning)	
Planning for Evacuations and Quarantining	Traffic operations centers with their ITS detection and surveillance systems can detect or confirm disasters and address the probable resultant transportation impacts. This will provide a centralized response team with the tools necessary to implement a traffic control plan supportive of the overall disaster response plan. This could include the quarantine of city streets or portions of highway and transit systems. Traffic flow information collected through ITS technologies allows engineers to pre-plan for the implementation of optimal evacuation routes to meet a variety of potential incidents.
Traffic Surveillance and Detection; Infrastructure Deployment	Closed circuit television cameras, traffic sensors (loop detectors, wireless sensors, and mobile phones as data probes), transponders, and optical image sensors typically monitor vehicles and infrastructure to provide data for traffic congestion mitigation. In addition to assisting in disaster response, these technologies may also be used to monitor roads for suspicious vehicles or to provide tracking of high-threat or high-interest vehicles.
Emergency Communications Hardening and Redundancy	ITS communications employ fiber optic cables, either deeply buried or, in urban areas, encased in conduit or ducts, resulting in a hardened communication system. ITS systems often also provide redundant network communications links, facilitating communications with and between traffic managers, law enforcement, and emergency services. Such systems may prove to be of crucial importance if natural disasters or terrorist attacks severely damage or destroy other telecommunications facilities.
Asset-Tracking for Commercial Vehicles, Transit Systems, and Cargo	Asset tracking involves the use of electronic means to locate specific vehicle or container movements, whether static or in transit. The security goal of the tracking function is to quickly recognize deviations from planned routes or other baseline information, and to effectuate measures to interrupt the further movement of an errant asset. In the event of post event activity the tracking function may assist in determining the origin of the asset, and its operator. Correlation with the Permitting function will facilitate a faster identification of the required on-scene response equipment (i.e. HAZMAT) thus reducing the potential impact of the incident.
Post-Event Applications (Response)	
Detection and Surveillance	ITS detection and surveillance technologies are also effective after the occurrence of the event. They allow traffic managers to pinpoint disaster locations, direct emergency response, verify ability of a route to accept additional traffic to support a diversion or evacuation, and manage traffic during evacuations. ITS sensors can also detect structural damage to bridges and tunnels. Archived vehicle-location data and closed circuit television camera tapes can aid law enforcement investigations post-event. The technologies described here are particularly useful in support of data and response archiving activities.
Real-Time Traffic Control	Using ITS technologies, traffic managers can quickly redirect traffic, reverse the flow of HOV lanes, and expedite evacuations from metropolitan centers to support the overall disaster or incident response plan. State of the art traffic signal systems allow traffic managers to re-time signals for optimum traffic flow and to blend the traffic flow entering or exiting a freeway system being used to support the overall response plan.

Table 5-3: ITS Homeland Security Applications (Continued)

ITS Application	Description
Traffic Operations Centers	Traffic operations centers are the command and control centers of surface transportation. These centers both collect and, in concert with the overall response plan, disseminate traffic flow and disaster-related data to the public. Operations centers also provide a central point of communications between emergency services and traffic managers to effectuate rapid incident response. Finally, these centers can redirect and optimize traffic flows throughout a metropolitan area.
Information Dissemination to the Public	Once the overall response plan has been developed, the supporting traffic flow and disaster information collected by ITS can also be quickly disseminated to the public through ITS. Electronic message signs on highways and traveler/weather information radio stations are two outlets that currently can provide notices to the public. Direct relationships with the media and information service providers also provides transportation information to radio and television stations as well as to traveler's personal information devices: mobile phones, personal digital assistants, e-mail, or telematics (in-vehicle) devices.
Telematics and Other Consumer Automobile Applications	Telematics systems are wireless in-vehicle communications and navigation systems. In those cases where an evacuation plan has not been established, navigation systems can provide dynamic route guidance, to empower the driver to make optimal evacuation decisions. For those cases where an evacuation route has been established interactive navigation systems can get the vehicle to the evacuation route without transiting a dangerous area – e.g. downwind plume, fires, flooding, etc. Mayday services speed emergency response to an individual car by signaling a vehicle's location information at the push of a button or through an automated crash notification system.
Data and Response Archiving	Tracking of response actions, traffic flows, errant vehicles, and condition of systems can be accomplished through system reporting and archiving functions, providing detailed information for both internal agency use as well as for media and public debriefing as appropriate.

Currently, there is no clearly labeled "transportation security/ITS" funding program that should be targeted. Rather, opportunities for accelerating ITS through linkages with transportation security are diffuse, i.e., there are traditional funding sources for public safety that have either been increased, or broadened to allow a wider range of uses, including ITS related, and ITS programs have been given a security spin (e.g., FHWA's FY 2003 Integration Program solicitation targeted security/public safety ITS applications). Given these circumstances, the recommended approach to leveraging transportation/homeland security funds for ITS is to reach out to those public safety agencies that may have shared needs, and access to new or increased funding. In addition to providing possible funding opportunities, this outreach will also support the more general objective of improved coordination with these organizations.

Public safety agencies, including law enforcement, fire departments, and emergency services have always represented good, and typically under-utilized, funding partners for ITS projects. These agencies can directly benefit from ITS resources and they utilize, and can share, a number of infrastructure components with transportation agencies, including communications systems. The increased focus on transportation security has made partnership with these agencies even more important.

It is strongly recommended that transportation agencies in the Houston region continue, and expand, their discussions with public safety agencies, to identify areas of partnership and to pool funding opportunities. In addition to work with local agencies, it is recommended that local ITS agency representatives contact the Governor's office to identify the state level strategy for homeland security and to insure proper representation of transportation, and ITS, interests.

5.8 Finance

This section identifies general strategies for ITS funding, including a summary of major transportation funding sources that may be applied to ITS. This information provides a basis for subsequent development of a specific funding action plan, which will establish a linkage between foreseeable funding availability and the ITS projects recommended in Section 7.0.

5.8.1 ITS Funding Principles

The following principles should be considered when pursuing funding for ITS projects:

- **There is No Federal ITS Funding "Pot of Gold"** – Especially in the early stages of ITS implementation several years ago, many regions believed that what they perceived as a new responsibility would be associated with a new, supplemental (i.e., in addition to traditional transportation funds) and sizable source of Federal ITS funds. This was never the case, and over the last several years, dedicated sources of Federal ITS funds have remained at levels not nearly adequate to substantially fund ITS implementation across the country. Most of the Federal funding that has been dedicated to ITS at the Federal level been earmarked through the political process.

- **Funding is Political in Nature** – Ultimately, the ability to fund ITS projects depends on securing political support, at all levels, which in turn requires public support. Building political support for the overall ITS program, and for specific ITS projects, early in project development, is critical. Focused efforts to reach out to inform senior agency management, political leaders and the general public are needed. Additional information on working in the political arena and public outreach are discussed in Section 6.0.

- **Multi-Jurisdiction Projects Are Easier To Fund** – Including multiple jurisdictions in ITS deployment efforts provides the dual benefits of enhanced coordination between the jurisdictions and it can galvanize the broad-based political support that helps attract funding (many Federal ITS funding program specifically encourage multi-jurisdictional efforts).

- **Persistence and Creativity Are Key** – Obtaining funds is often a "hit and miss" activity. Sometime project sponsors and deployment champions get into the rut of thinking that only one particular type of funds may be applied to a specific type of ITS project. This is never the case, as most funding sources are open to many types of projects. The key is identifying all of those funding sources that may be available, and putting in the effort needed to obtain funding. The recent Federal trend toward ITS mainstreaming, that is, increasing funding in traditional transportation programs and loosening restrictions to allow those funds to be used for operations/ITS, provides further motivation to fully consider all funding sources.

- **Include ITS As a Standard Part of Traditional Transportation Projects** – ITS Projects Do Not Compete with Traditional Transportation Projects for Funds – ITS should be viewed as simply one of the many components that should be included in the expansion and improved management of the transportation system. ITS elements should be a standard component of new road building and reconstruction; ITS elements should be included in new bus purchases, etc. The deployment of ITS on existing facilities can be viewed as retrofitting and updating the facilities to current standards.

- **Mainstream ITS in the Local Planning and Programming Process** – ITS should be incorporated into the regional transportation planning and programming process. ITS should be incorporated into the Regional Transportation Plan (RTP). At first, ITS may appear as a separate section in the RTP, however, the goal should be to eventually integrate ITS fully into other transportation activities.

- **Public/Private Partnerships Hold Promise, But Are Challenging** – Successful partnerships with private sector partners are possible in a number of areas, however, structuring truly mutually-beneficial partnerships that will be viable for extended periods is quite challenging. It is critical to build the partnership "angle" into the basic project definition, early in the planning and design stage, and to clearly define the intended end, but remain flexible to private sector entrepreneurship regarding the means (see Section 5.6).

5.8.2 Federal ITS Funding Programs

There are no large, dedicated ITS funding programs to support wide-scale local implementation of ITS. For the most part, deployment of local ITS infrastructure, such as traffic signal controllers and dynamic message signs, must compete with "traditional" or non-ITS projects for funding under "traditional" funding programs, such as the Surface Transportation Program. Fortunately, the funding levels of these traditional programs have been increased under the current federal transportation legislation, TEA-21. Unfortunately, since most areas have a "waiting list" of unfunded transportation projects, there will be stiff competition for the extra funds.

There are some *dedicated* federal ITS funds, however, they are not sufficient to fund major local infrastructure deployments, both due to the modest size of the programs—funding levels are far less than necessary to meet demands nationwide—and because use of the funds is restricted to certain activities and areas.

The sections below summarize both the ITS-dedicated and the non-dedicated but ITS eligible funding programs under TEA-21.

5.8.3 Dedicated ITS Funding Programs

The Intelligent Transportation Systems Act of 1998 (the provisions of TEA-21 that define the ITS program) is divided into two primary sections. The first is ITS Deployment and the second is ITS Research and Development. This structure reflects the fundamental shift away from a research and development (R&D) program, to one more balanced between R&D and infrastructure deployment. Table 5-4 lists the dedicated federal ITS funding programs.

Just over $100 million per year is available during TEA-21's 6-year life. In addition, TEA-21 has created an ITS Deployment category which provides an additional $113 million per year for implementation of ITS projects. However, "earmarking," or the practice of funding to specific projects at the suggestion of members of Congress, has had a significant impact on the availability of these funds. (Practically all of the Deployment program funds under TEA-21 have been allocated to "earmarked" projects.) The minimum, non-local matching share under these programs is 20 percent. Furthermore, since there is no state-by-state allocation of ITS funds, competition for these limited funds will require local congressional support (i.e., "earmarking") or a larger state matching percentage—up to 50/50 match as envisioned by the FHWA.

Table 5-4: Dedicated Federal ITS Funding

ITS Program Funding ($ in millions)							
Year	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**	**Total**
R&D	95	95	98	100	105	110	603
Deployment	101	105	113	118	120	122	679
Total	196	200	211	218	225	232	1,282

5.8.3.1 <u>ITS Research and Development</u>. The R&D portion of the ITS program encompasses all other aspects of the program not included under Deployment. This includes funding of early deployment plans, the Intelligent Vehicle Initiative, as well as research on metropolitan travel management, rural ITS services, advanced public transportation systems, and commercial vehicle applications. This portion also includes program support activities, including continued maintenance and expansion of the National ITS Architecture, development and testing of ITS standards, and providing technical assistance and training.

5.8.3.2 <u>ITS Deployment</u>. The purpose of the ITS Deployment section of TEA-21 is to fund small incentive grants to states and local governments to deploy integrated intelligent transportation systems through two ways: the ITS Integration Program and Commercial Vehicle ITS Infrastructure Deployment.

1) ITS Integration Program

The purpose of the ITS Integration Program is to accelerate the integration and interoperability of intelligent transportation systems in metropolitan and rural areas through small funding incentives. TEA-21 directs between $74 and $85 million per year over its 6-year life. It also stipulates that at least 10 percent of these funds will be directed toward rural areas. In metropolitan areas, the money may be used only for integrating existing — or legacy — systems, or integrating new systems funded from other sources e.g., traffic signal systems, preemption systems, etc. Deployment of ITS infrastructure components is not eligible for urban projects. In rural areas, the money may be used for integrating legacy systems, as well as for deploying new ITS infrastructure components.

TEA-21 lists several requirements for project funding under the Integration Program. Projects must:

- Contribute to national deployment goals and objectives;
- Demonstrate strong commitment among stakeholders;
- Maximize private sector involvement;
- Demonstrate conformity to the National ITS Architecture and use approved ITS standards and protocols;
- Be included in statewide or metropolitan transportation plans;
- Ensure continued long-term operations and maintenance; and
- Demonstrate that personnel have necessary technical skills.

Because these guidelines are relatively new and fairly broad, a wide range of projects could qualify for funding. Examples of such projects would be expanding an existing traffic signal system to include transit vehicle priority preemption, or providing freeway surveillance data to local agencies for use in new or existing traveler information systems.

For an individual project, the federal cost share from the ITS Integration program is not to exceed 50 percent, and the federal share from all sources (such as regular federal aid) is not to exceed 80 percent.

2) Commercial Vehicle ITS Infrastructure Deployment

TEA-21 seeks to advance the technological capability and promote the deployment of ITS applications to commercial vehicle operations. The program's goals are to improve the safety and productivity of commercial vehicles and drivers, and to reduce costs associated with operating and regulating commercial vehicles in the United States. These goals will be met by directing project funds toward the Commercial Vehicle Information Systems and Networks, or CVISN, infrastructure. The CVISN infrastructure will enable states to provide:

- Automated roadside inspections that target unsafe carriers;
- Automated vehicle screening and weighing at international border crossings and weigh stations; and
- Electronic credentialing and automated tax reporting and filing.

TEA-21 sets the goal for the CVISN infrastructure to be deployed in a majority of States by September 30, 2003. Similar to the requirements of the Integration Program, for individual projects, the Federal cost share from ITS program funds is not to exceed fifty percent, and the Federal share from all sources is not to exceed eighty percent.

5.8.4 Non-Dedicated ITS Funding Programs

With TEA-21, as was the case with ISTEA, the major sources of funding for ITS-related projects are the Federal-aid highway programs and the Federal Transit Administration programs. Funding for ITS projects is obtained through the same local programming as "traditional" projects. Once the project request is received, it is reviewed for applicability under the various funding programs by state and local officials and prioritized along with all other requested projects.

There are six specific areas of TEA-21 that may be utilized to access over $122 billion for project implementation. In every case except for the FTA 5307 program, toll revenue credits may be used as the local match share for these funds. (Toll revenue credits represent the cost to the operator of an interstate toll road for system maintenance. No toll revenue is actually transferred to FHWA. Rather, a portion of the annual maintenance and authorized capital cost of the facility is eligible to be used as matching funds. The use of Toll Revenue Credits must have the approval of the State D.O.T.).

5.8.4.1 **<u>ITS Operations and Maintenance Funds</u>**. Operations and maintenance (O&M) funding is a particular concern for many jurisdictions, so it's important to specifically clarify the use of federal funds for these purposes. In the case of National Highway System and Surface Transportation Program funds, funds may be used indefinitely (through the life of TEA-21) for ITS operations and maintenance assuming that the ITS project itself satisfies the basic eligibility provisions associated with the particular funding source. For example, assuming an ITS project satisfies the funding eligibility requirements for National Highway System (NHS) funds, the funds can be used for either construction or O&M.

In the case of the Congestion Mitigation and Air Quality Improvement (CMAQ) program, funds for many types of projects, including new transit services, can be used for O&M for only three (3) years, with no provisions for time extensions. For traffic flow improvements—which TEA-21 defines as including a wide range of ITS projects including regional multi-modal traveler information systems, traffic signal control systems, freeway management systems, incident management and systems—CMAQ funds can only be used for three years, with special provisions for continued use of the funds. In order to continue using the funds for O&M, a special consultation with the EPA is required. If it can be shown that "the continued operation of the project will assist in the attainment or maintenance of an air quality standard", the funds can continue to be used beyond the three-year limit (FHWA TEA-21 web site; www.fta.dot.gov/fta/library/planning/enviro/cmaq.htm; July 28, 1999). Given the air quality benefits of ITS traffic flow improvements, the potential for continued use of CMAQ funds seems promising.

5.8.4.2 **<u>Summary of Non-Dedicated Federal ITS Funding Sources</u>**. Each of the six TEA-21 funding programs that may be used for ITS are summarized below. In all cases, a 20 percent local match is required.

1) Surface Transportation Program (STP)

STP Funding is available to MPO's and County Engineers for improvements to eligible Federally Classified Highway System Routes and Transit systems. Local traffic management and traffic control projects are eligible under this program. TEA-21 amended prior legislation (ISTEA) by specifically allowing STP funds to be used for infrastructure based intelligent transportation system capital improvements. Total funding for STP is $33.3 billion over the 6-year life of TEA-21. However, 10 percent of all STP funds must be spent on safety projects and another 10 percent on Transportation Enhancements, reducing the amount of available STP Funds to $26.6 billion.

2) National Highway System (NHS)

The NHS program is similar to STP in that the funds may be spent only on designated NHS roadways. States can (if they desire) transfer NHS funds to their STP pool with DOT approval.

TEA-21 amended prior legislation (ISTEA) by specifically allowing STP funds to be used for infrastructure based intelligent transportation system capital improvements. The program is funded at $28.6 billion over the life of TEA-21.

3) Congestion Mitigation and Air Quality Improvement Program (CMAQ)

Due to the favorable impacts of ITS projects on mobile emissions and fuel consumption, CMAQ has become a popular source of funding for traffic signal and traffic management projects. CMAQ funds must be used in EPA-designated "non attainment" or "maintenance" areas for projects which can demonstrate air quality benefits, which includes a wide range of ITS activities. The program provides $8.1 billion over the life of TEA-21.

4) Interstate Maintenance Program (IM)

TEA-21 made minor changes to the regulations governing the use of Interstate Maintenance funds. These changes, however, had no effect on the implementation if ITS-related projects on the Interstate Highway System. Improvements such as ramp metering, freeway surveillance, variable message signs, etc., are fundable under the IM program whether or not they are part of a larger 4R (Resurfacing, Restoring, Rehabilitation, and Reconstruction) project. Total funding under the IM program is $23.8 billion.

5) Federal Transit Administration (FTA) 5309 – Capital Program Grants and Loans

This program is one of two transit programs with money eligible for ITS under TEA-21. Of the $41 billion for transit in TEA-21, $28.2 billion is eligible for ITS projects under one of these two programs. Traditionally the 5309 funds have been used to fund new starts, fixed guideway modernization, and bus acquisition and these programs can fund innovative techniques and practices for management of public transit. Availability of these funds for ITS purposes should be considered limited due to commitments to "earmarked" projects. TEA-21 allocates $12.6 billion for this program over 6 years.

6) FTA 5307 – Urban Formula Grant Program

Like the 5309 Capital Program, this program also permits FTA funds to be used for both capital and maintenance costs of Advanced Public Transportation System (APTS) projects. Although 6-year funding amounts to $15.6 billion, ITS-related projects must compete with other Formula Grant projects.

Table 5-5 summarizes the applicability of the Federal ITS programs described in this section to various types of ITS projects.

5.9 Public Awareness/Involvement

Building awareness and support for the Houston region ITS program is critical to the program's success. First, funding availability is ultimately a political issue, which makes it important that the public appreciate and value ITS investment, and that these public views are known by the political figures who make the high level funding decisions. Second, unlike adding extra lanes to roads, the public often has to be persuaded to utilize ITS facilities and services. Further, the benefit of those ITS investments is only realized when they are well utilized.

Table 5-5: Applicability of Federal Funds to ITS Projects

Project Type/Phase	Federal Funding Source								
	Dedicated ITS Sources				Non-Dedicated (Traditional) Sources				
	Research and Development	Deployment			STP	NHS	CMAQ	IM	FTA
		Integration [1]		Commercial Vehicle					
		Urban	Rural						
Freeway/Incident Management Feasibility/Planning	●	O	●	●	O	O	O	O	X
Research/Demo	●	O	●	●	O	O	O	O	X
Design/Construction	X	O	●	●	O	●	●	●	X
O&M	X	X	X	O	O	●	●	●	X
Arterial Streets/Traffic Signals Feasibility/Planning	●	O	O	O	O	O	O	X	O
Research/Demo	●	O	O	O	O	O	O	X	O
Design/Construction	X	O	O	O	●	●	●	X	O
O&M	X	X	X	O	●	●	●	X	X
Transit Feasibility/Planning	●	O	O	X	O	O	O	X	●
Research/Demo	●	O	O	X	O	O	O	X	●
Design/Construction	X	O	O	X	O	O	O	X	●
O&M	X	X	X	X	O	O	O	X	● [2]
Regional Traveler Information System Feasibility/Planning	●	O	●	X	O	O	O	O	O
Research/Demo	●	O	●	X	O	O	O	O	O
Design/Construction	X	O	●	X	O	O	O	●	O
O&M	X	X	X	X	O	O	O	●	O [2]

[1] In urban areas, funds can only be used for *Integration* with existing systems. In rural areas, funds can be used for any ITS infrastructure. Generally, the eligibility for *Integration* funds will vary considerably form project to project in urban areas, depending on the extent to which the project interfaces with existing systems.

[2] FTA funds cannot be used for operations, but they be used for maintenance.

Legend:

- ● = Funding source has **high** applicability to this type of project/phase of project.
- O = Funding source has **low** applicability to this type of project/phase of project, but funding is possible.
- X = Funding source is generally not applicable to this type of project/phase of project

For these reasons, it is highly recommended that the Houston region include a multi-faceted, long-term public awareness and involvement component within their overall ITS strategy. We recognize that several efforts currently provide ITS outreach. The complete list of recommended components of the ITS outreach strategy include:

- Printed ITS education and promotion materials, such as pamphlets (both Houston region-specific, and selections from the USDOT's extensive library of national public ITS literature), newsletters and annual reports.
- ITS presentations, targeted to specific audiences, including various public and business community groups.
- ITS displays/exhibits, for use in bulletin boards and lobby displays in government buildings and at a major civic functions and celebrations.
- ITS web site(s).
- Press releases, press conferences and other media promotion.
- Public "grand openings" of ITS facilities and services.
- Making tours of ITS facilities available to civic and school groups.
- ITS branding – placing TranStar or TxDOT on news programs, advertisements, announcements, etc.

5.10 Maintenance

Operation and maintenance are key to a successful and sustainable ITS system. It is important to include operation and maintenance costs when planning an ITS project. Operations and maintenance costs, often referred to as recurring cost, are the costs that are incurred on an ongoing basis. Typical examples include utilities for a traffic operations center such as Houston TranStar, wire-line or wireless monthly fees, labor costs, maintenance costs of roadside sensors (e.g., loop detectors, flood sensors), optical fibers, and Closed Circuit Television Cameras (CCTV).

Maintenance requirements should be a factor in selecting ITS technologies. For example, for traffic detection, inductive loop detectors cost a lot less than more sophisticated microwave or image-based sensors. However, the inductive loop detectors are generally unreliable and require frequent repair and maintenance (which causes disruption of traffic) that cost a lot more than the other sensors. Cost analysis that accounts for capital and operation/maintenance costs need to be performed in support of the procurement decisions.

5.11 Staff Resources & Training

Successful planning, design, implementation and operation of ITS in the Houston region requires a number of skills that may not be common to many area transportation professionals, including those related to advanced technology procurement and contracting procedures, communications and system integration. For this reason, it will be important for the region to assess its ITS skills and training needs and to implement measures to insure that critical needs will be met, through some combination of training or hiring of public agency personnel and use of contractors.

It is recommended that the Houston region, led by the HGAC, develop an ITS training and capacity building (TCB) strategy. To a large extent, the plan will focus on identifying the desires on the part of local agencies in better coordinating their ITS training and capacity building. The scale of the regional effort should be directly proportional to the expressed interest and willingness to participate on the part of ITS operating agencies.

Potential actions that may be recommended in the regional TCB strategy include:

- Identifying a local TCB champion and linking TCB activities to existing ITS committee activities (e.g., establish a subcommittee).
- Assemble and maintain a library of ITS references and training materials.
- Include ITS TCB resources on the ITS portion of the regional transportation web page.
- Conduct ITS workshops and training sessions.
- Identify opportunities to partner with national professional associations such as ITS America and the Institute of Transportation Engineers and Texas universities.
- Develop general training and competency guidelines for various categories of public agency ITS staff.
- Implement a local version of the FHWA and FTA Peer-to-Peer Program to promote information sharing.

As part of the development of a regional TCB strategy, a survey of ITS agencies is recommended to determine needs and priorities. The survey should include ranking of the priority for training in specific knowledge areas. The knowledge areas identified in the FHWA Joint Program Office's Professional Capacity Building Program represent an excellent basis for this skills list. That program identifies areas such as:

- Cost/Benefit Analysis
- Technology Analysis
- System Integration
- Funding Sources
- Specification Writing
- Project Evaluation
- Procurement Options
- Data Sharing

The survey should also ask respondents to indicate their preferences for training methods (e.g., workshops/classes/seminars, on-the-job and peer-to-peer, professional associations, etc.) and training providers (e.g., commercial vendors, Federal agencies, Universities, etc.). The results of the survey should be used to drive the development of the regional ITS TCB strategy.

5.11.1 <u>Existing ITS Training and Capacity Building Resources</u>

The TCB strategy developed for the Houston region should include, as appropriate, utilization of the many existing ITS TCB resources that are available. These resources include:

- Workshop/classroom instructional courses offered by:
  - FHWA National Highway Institute
  - FHWA Joint Program Office
  - National Transit Institute
  - Transportation Safety Institute

- Texas Universities – participation in transportation research projects and development of future staff (students)

- Professional associations offering training workshops, including:
  - ITS America
  - Institute of Transportation Engineers (ITE)
  - American Association of State Highway Transportation Officials (AASHTO)
  - American Society of Civil Engineers (ASCE)
  - Women's Transportation Seminar (WTS)

- Federal ITS Professional Capacity Building short courses and seminars offered in downloadable format (http://pcb.volpe.dot.gov/information.asp)

- Interactive, on-line training courses available through the Consortium for ITS Training and Education, CITE (http://www.citeconsortium.org)

- Downloadable presentations and documents on a wide range of ITS topics from USDOT (http://www.its.dot.gov), National Transportation Library (http://nti.bts.gov), ITS America (http://itsa.org), ITS Cooperative Deployment Network (www.nawgits.com), and the Electronic Document Library (http://www.its.dot.gov/itsweb/welcome.htm)

- FHWA and FTA Intelligent Transportation Peer-to-Peer Technical Assistance Program, which provides funding in support of site visits and other activities.

5.12 Performance Measures

Performance measures are quantifiable indicators of the region's transportation performance in supporting the Regional ITS Strategic Plan through ITS deployments. By defining specific performance measures, the region can monitor the effectiveness of ITS programs in meeting their goals and objectives for transportation.

Table 5-6 summarizes the recommended ITS performance measures for the Regional ITS Strategic Plan for Houston. These measures are consistent with the goals and objectives identified in the 2022 Metropolitan Transportation Plan (published by the Houston-Galveston Area Council), as well as with National and Statewide ITS goals. Secondary goals were identified based on critical technical and institutional needs for the region as summarized in the Houston Region System Architecture. These goals and objectives were then translated into specific performance measures along with the data requirements needed to provide tangible results.

Table 5-6: Regional ITS Strategic Plan Performance Measures

Goals and Objectives		Performance Measures	Data Requirements
1.0 Reduce Traffic Congestion			
1.1 Reduce Traffic Congestion on Interstates and Arterials			
1.1.1	Improve travel times along freeway corridors	Travel time (minutes)	Travel time studies using probe vehicle data
1.1.2	Improve travel time reliability of freeways	Travel time reliability	Travel time studies using probe vehicle data
1.1.3	Reduce vehicle-miles of travel	Total vehicle-miles of travel on freeways during the peak hour.	Traffic counts by hour by day of week. Department of Transportation estimates, loop counts
1.1.4	Improve peak period speeds	Average peak hour speed	Average vehicle speed obtained through traffic flow studies
1.1.5	Reduce queuing onto interstate mainlines	Travel time (minutes) along corridors equipped with ramp metering Coverage of ramp metering	Travel time studies using probe vehicle data Miles of freeway equipped with ramp metering
1.2 Improve Incident Detection and Management			
1.2.1	Improve abilities to detect, verify, respond, and clear incidents	Average time to detect and verify incidents Average time to respond and clear incidents	TranStar incident log records Accident reports, Motorist Assistance Patrol records
1.2.2	Reduce delays caused by congestion during special events	Total delay in vehicle-minutes	Travel time studies using probe vehicle data to estimate delay
1.3 Improve arterial management			
1.3.1	Monitor conditions on arterials using ITS technology	Implement traffic detection and surveillance technologies on arterials	Miles of arterials equipped with traffic management detection and surveillance technologies
1.4 Improve Traffic Signal Operations			
1.4.1	Improve signal synchronization	Arterial level of service	Flow studies on arterials to determine level of service based on arterial classification, running time, intersection delay, and average travel speed
1.4.2	Obtain regional control of traffic signal operations	Implement regional computerized traffic signal system	Number of intersections equipped with regional computerized traffic signal system
1.5 Manage Construction and Work Zones			
1.5.1	Reduce delays caused by congestion in construction work zones	Total delay in vehicle-minutes	Travel time studies using probe vehicle data to estimate delay

Table 5-6: Regional ITS Strategic Plan Performance Measures (Continued)

Goals and Objectives		Performance Measures	Data Requirements
1.6 Expand the Use of Electronic Payment			
1.6.1	Expand and integrate electronic payment for tolls, transit fare payments, parking, and other services	Total delay at tollbooths in vehicle-minutes	Harris County Toll Road Authority records. Number of EZTag users; processing rates at tollbooths
1.7 Provide Better Traveler Information			
1.7.1	Provide traveler information services with alternative route and mode choice information	Implementation	Advanced Traveler Information Systems (ATIS) Content
1.7.2	Improve traveler information on incidents	Implementation	ATIS Content
1.7.3	Provide information to travelers on construction and work zones	Implementation	ATIS Content
1.7.4	Provide parking availability information	Implementation	ATIS Content
1.7.5	Provide delay and arrival time information at transit park and ride locations and bus stops	Implementation	ATIS Content
1.7.6	Provide trip itineraries to the public for trip planning and travel choices	Implementation	ATIS Content
1.7.7	Provide better information on Dynamic Message Signs (DMS) and Highway Advisory Radio (HAR)	Develop standards for information content and display/broadcast	ATIS Content
1.7.8	Implement and promote the use of 511 for information dissemination	Implementation	ATIS Delivery
1.7.9	Provide for cell phone, PDA and other remote access	Implementation	ATIS Delivery
1.7.10	Provide information kiosks and video monitors	Implementation	ATIS Delivery
1.7.11	Expand the use of Dynamic Message Signs (DMS)	Number of DMS installed on freeways	ATIS Delivery
1.7.12	Install DMS on arterials to support traffic operations and special events	Number of DMS installed on arterials	ATIS Delivery
1.7.13	Expand the scope and accessibility of Highway Advisory Radio (HAR)	HAR coverage area	ATIS Delivery
2.0 Maintain and Preserve the Existing Road System			
2.1 Improve Commercial Vehicle Management & Safety			
2.1.1	Improve signage to intermodal, port, airport, and truck terminal facilities	Designation and signing of routes to intermodal facilities	Signage inventory
2.1.2	Improve enforcement of illegally overweight vehicles	Overweight vehicle enforcement coverage	Number of weight-in-motion stations in the region, Number of enforcement units
2.1.3	Provide automatic enforcement of commercial vehicle regulations	Implementation	Number of stations equipped with electronic credentialing, Number of enforcement units

Table 5-6: Regional ITS Strategic Plan Performance Measures (Continued)

Goals and Objectives		Performance Measures	Data Requirements
2.2 Improve Data Collection and Warehousing			
2.2.1	System evaluation and alternative analysis	Data collection system spatial coverage	Provide data collection system coverage for all freeways equipped with ITS, type of data collected, quality of data collected.
2.2.2	Support highway operational performance reporting, modeling, simulation, and other techniques for operations and management of the system	Implementation of data collection system that supports stated functionality	Type of data, quality of data being used for operational performance.
2.2.3	Support the monitoring and collection of data for transportation and transit planning applications	Implementation of data collection system that supports stated functionality	Data types, quality of data, data supply, and data coverage
3.0 Improve Travel Options			
3.1 Improve Existing HOV Lane Management			
3.1.1	Expand miles of HOV lane coverage outside the METRO service area	HOV lanes coverage	METRO records; miles of HOV lanes outside of METRO service area
3.1.2	Improve existing HOV lane management	Surveillance and motorist info coverage	Miles of surveillance and ATIS coverage (e.g., CCTV cameras, AVI readers, DMS)
		Service patrol coverage	Miles of MAP coverage
		Enforcement coverage	Miles of Police coverage
		Throughput	HOV lane vehicle counts, average vehicle occupancy, traffic flow data
		Incident reduction	Accident records (police and insurance)
		Travel time reliability	Travel time studies using probe vehicle data
3.1.3	Increase public awareness of HOV lanes	Implement public outreach program on HOV lane use and safety	Dollars spent on public outreach, No. of mailings sent out or advertisements in place.
3.1.4	Reduce single occupant vehicle travel	HOV lane person throughput (persons/hour)	HOV lane vehicle counts, average vehicle occupancy, traffic flow data
		Vehicle occupancy	Average vehicle occupancy from vehicle studies or the National Personal Transportation Survey
3.1.5	Improve safety of HOV lanes	Total number of accidents per year	Accident records (police and insurance)

Table 5-6: Regional ITS Strategic Plan Performance Measures (Continued)

Goals and Objectives		Performance Measures	Data Requirements
3.2 Develop Improved Transit Management Strategies			
3.2.1	Provide viable travel modes to the public	Transit service coverage within the region	Transit availability model in Transit Capacity and Quality of Service Manual
3.2.2	Collect ridership and other data for transit route planning purposes	Implementation of data collection system that supports stated functionality	Accuracy and percentage of ridership data collected.
3.2.3	Monitor transit vehicle location	Number of buses equipped with AVL Accuracy of transit vehicle location	METRO Records METRO Records
3.2.4	Encourage greater use of mass transit, ridesharing, vanpooling, telecommuting, and other demand-management programs.	Transit ridership HOV lane usage Number of METRO-sponsored vanpool programs Person throughput (persons per hour) Implement outreach programs to educate companies on demand-management programs	Boarding and alighting counts HOV lane volume METRO records Vehicle counts, average vehicle occupancy, traffic flow data. Company address listing, zip code distribution
4.0 Air Quality Compliance			
4.1 Ensure Air Quality Compliance			
4.1.1	Reduce air quality emissions from mobile sources	Total delay in vehicle-minutes Emissions estimates Number and severity of ozone exceedances in the eight-county region.	Travel time studies using probe vehicle data to estimate delay Travel demand model data and EPA mobile source emission rates Data from air monitoring sites
5.0 Safety and Security Planning			
5.1 Monitor Motor Vehicle Crashes			
5.1.1	Reduce accident rates caused by driver errors and the severity of accidents	Total number of accidents per year	Accident records (police and insurance)
5.1.2	Reduce accident rates and severities on HOV lanes	Total number of accidents per year	Accident records (police and insurance)
5.1.3	Reduce accident rates and severities at highway-rail grade crossings	Total number of accidents per year	Accident records (police and insurance)
5.1.4	Reduce accident rates and severities in construction work zones	Total number of accidents per year	Accident records (police and insurance)

Table 5-6: Regional ITS Strategic Plan Performance Measures (Continued)

Goals and Objectives		Performance Measures	Data Requirements
5.1.5	Reduce secondary accidents that result from “rubber-necking” during incidents	Total number of accidents per year	Accident records (police and insurance)
5.2 Improve Commercial Vehicle Management & Safety			
5.2.1	Reduce the occurrence of truck rollovers	Implement truck rollover warning devices throughout the region Number of truck rollovers	Number of interchanges equipped with truck rollover warning system Annual number of truck rollovers in the transportation management area
5.2.2	Implement dedicated truck lanes	Miles of dedicated truck lanes	TxDOT records
5.2.3	Provide routing for oversize trucks	Designation and signing of detour routes	Signage inventory
5.3 Manage Hazardous Materials Transportation			
5.3.1	Improve ability to verify HAZMAT incidents	Remote sensing capabilities Average time to detect and verify HAZMAT incidents	No. of environmental sensors, ITS surveillance coverage (no. of CCTV cameras), Shipper records No. of incidents, TranStar incident logs. ITS surveillance coverage (no. of CCTV cameras)
5.3.2	Improve HAZMAT response systems	HAZMAT response system coverage	No. of lives lost in HAZMAT incidents, Dollars in property damage, Average time to restore traffic operations after HAZMAT incident
5.3.3	Provide routing of vehicles carrying hazardous materials away from residential areas	Designation and signing of detour routes	Signage inventory
5.3.4	Develop incident management and personnel plan for HAZMAT incidents	Implement incident management response plan for HAZMAT incidents	Percent of HAZMAT incidents in which incident management response plan was used.
5.4 Enhance Emergency Management			
5.4.1	Develop a regional emergency management plan	Develop and implement regional emergency management plan	No. of agencies included in regional emergency management coordination, No. of agencies trained in emergency management procedure
5.4.2	Share emergency information among local and regional agencies and emergency management facilities	Communication links to county EMC’s and shelter management personnel	No. of county EMC’s and shelters linked to TranStar
5.4.3	Improve agency coordination during evacuations	Memoranda of understanding	Agencies included in Memoranda of understanding
5.4.4	Obtain and use traffic data for evacuation routing	Traffic monitoring coverage on designated evacuation routes	Miles of evacuation routes equipped with traffic management detection and surveillance technologies
5.4.5	Use roadside ITS during emergencies	Implementation of ATIS technologies on designated evacuation routes	ATIS delivery

Table 5-6: Regional ITS Strategic Plan Performance Measures (Continued)

Goals and Objectives		Performance Measures	Data Requirements
5.4.6	Provide accurate and timely traveler information regarding traffic/travel conditions on evacuation routes and updated weather information	Implementation	ATIS content
5.4.7	Reduce delays to emergency vehicles at traffic signals	Implement traffic signal preemption for emergency vehicles	Traffic signal preemption coverage (no. of agencies, vehicles, and intersections)
5.5 Improve and Expand the Scope of Flood Monitoring Systems			
5.5.1	Improve monitoring of flooding on arterials	Reliability and coverage of flood monitoring sensors on arterials in flood prone areas	Flood monitoring data
5.5.2	Improve monitoring of flooding in the bayous using ITS technology	Reliability and coverage of flood monitoring sensors in the bayous	Flood monitoring data
5.6 General protection of drivers and pedestrians in all modes of transportation			
5.6.1	Train first responders to react to hostile situations	Publish training needs assessment and implement	Percent of responders trained
6.0 Deploy an Integrated, Effective System			
6.1 Ensure standards compliance for all the ITS systems		Implement standards compliance board and quality assurance program	Percent of systems that are standard compliant
6.2 Provide redundancy to critical ITS systems such as emergency management and traffic control systems		Implement backup systems and plans for critical ITS systems	Percent of systems equipped with backup capabilities
6.3 Improve Agency Coordination			
6.3.1	Develop a regional approach for the design, implementation, integration and testing of ITS that includes regular updates and enhancements of the regional ITS architecture	Achieve consensus and publish the plan	Agency consensus
6.3.2	Develop implementation and integration plan	Memoranda of understanding	No. of agencies involved in memoranda of understanding
6.3.3	Promote public-public partnerships to leverage financial and human resources	Percent of project costs funded (total cost) through public-public partnerships	Agency fiscal records
6.3.4	Reduce institutional barriers	Joint participation agreements	Agencies involved in joint participation agreements
6.4 Improve Communications Between Centers			
6.4.1	Implement high-speed communication link between TranStar and other entities to share data and control	Communication links to smaller regional traffic management centers and interested agencies	No. of smaller regional traffic management centers and interested agencies linked to TranStar
6.5 Dedicate a percentage of funds for operations and management of ITS deployments.		Implement ITS funding targets for the region	Agency fiscal records, Percent of ITS funds programmed for operations and maintenance
6.6 Identify Standard Performance Measures for Evaluating ITS Deployments		Publish performance measures and archive data requirements and implement	Data necessary to support estimation of performance measures
6.7 Integrate ITS into the Transportation Planning Process		Publish or adopt guidelines	Percent of transportation planning projects that include an ITS component

Table 5-6: Regional ITS Strategic Plan Performance Measures (Continued)

Goals and Objectives	Performance Measures	Data Requirements
6.8 Increase public awareness and understanding of ITS	Develop and implement public outreach program on ITS	Dollars spent on public outreach, No. of mailings sent out or advertisements in place.
6.9 Increase the professional capacity of the public and private sectors in the region to support planned deployments.	Complete training needs assessment and implement structured training program	Number of public and private sector transportation professionals trained
6.10 Generate an ITS Vision for the Region	Develop ITS Vision	Regional needs, goals, and objectives
6.11 Reduce the Use of Proprietary Systems	Percent of ITS deployments that are non-proprietary and capable of plug and play	ITS project records
6.12 Coordinate Rural and Urban ITS Deployments	Develop a deployment plan and regional architecture in accordance with Rule 940 Develop a systems engineering management plan	Rural and urban ITS deployments, Critical technical and institutional needs Rural and urban ITS deployments, Critical technical and institutional needs
6.13 Identify Funding Opportunities	Tracking of federal demonstration projects and field operational tests	Federal records, Internet access

6.0 ROLES AND RESPONSIBILITIES IN REGIONAL ITS DEPLOYMENTS AND OPERATIONS

This section of the Houston Region ITS Strategic Plan provides suggested deployment guidelines, including generalized agency roles and responsibilities, to support the development of ITS. There are three key actions which should be undertaken in the area to promote successful ITS deployment:

- Appropriate components of the Houston Region ITS Strategic Plan should be incorporated into the regional transportation planning process and the Regional Transportation Plan. This is consistent with the USDOT concept of mainstreaming ITS into transportation deployments. The goal is to approach ITS similar to any other transportation deployment effort.

- All significant transportation management and information system deployment efforts should be carried out in a cooperative manner within the metropolitan area with projects being proposed, promoted, and deployed with due consideration for the integration objectives of the metropolitan area.

- Consideration should be given to the potential rural applications of major system deployments in the more urban areas of the metropolitan area to maximize any economies of scale possible throughout the area.

This section is meant to provide suggestions, not prescriptive requirements. The most important component of successful area-wide ITS deployment is the active and continuous cooperation between transportation stakeholders.

The Houston region enjoys a tremendous advantage relative to many regions in that a successful core ITS program is in place that involves several of the major transportation operating agencies in the region. Expanding the current program to include additional cities, counties and other agencies in the greater region, and enhancing the core ITS services now provided, are the focus of future efforts. The project "Enhance Agency-Agency Outreach, Coordination/Communication—described in Section 7.0—provides the mechanism for much of this effort. The section that follows underscores the importance of continued sponsorship of the regional ITS program, both in terms of agency roles and the roles of individual deployment champions—a key to successful expansion.

6.1 Continued Sponsorship of the ITS Program

The current Houston region ITS program, spearheaded by the regional TranStar partnership among TxDOT, City of Houston, Harris County and METRO, has been highly effective and will serve as the basis for expansion of ITS activities to other organizations in the region. Continued sponsorship of ITS in the region will stem from two areas: (1) transportation agencies and other area organizations; and (2) individual program and project champions that promote specific components of the ITS program. Each of these areas is discussed in the following sections:

6.1.1 Agency Sponsorship

ITS deployment should be regional in character. Even small local deployments can leverage funding for regional projects when the larger project or system is deployed within the context of the overall Houston Region ITS Strategic Plan. TxDOT, City of Houston, Harris County, METRO and other major transportation and emergency service agencies within the region should work cooperatively with local jurisdictions in building partnerships and deploying projects that fit within the structure of the Strategic Plan. Other cities and counties should play key and cooperative roles in deploying ITS throughout the area. Specific sponsorship roles are discussed for some of the area's larger transportation players below.

6.1.1.1 HGAC. In general, HGAC should be the keeper of the Houston Region ITS Strategic Plan and ensure that appropriate elements of the Plan are incorporated into the regional transportation planning process. HGAC should attempt to establish standards and supporting tools for cooperative deployments in the ITS area. They should be a key player in the provision of ITS project/deployment champions. HGAC should take the lead in the regional promotion of ITS and in introducing political interests to the concept and benefits of ITS. They should continue to work to organize and support agencies that are attempting to promote, fund, program, and deploy ITS projects. As it is a regional agency, HGAC may often be able to operate as an effective umbrella agency for multiple local jurisdictions working cooperatively in ITS procurement efforts. HGAC should also play a key role as the maintainer of the regional system architecture, and a coordinating and advisory role in helping to insure that ITS projects are consistent with the architecture. HGAC's recommended role in system architecture conformity is described in greater detail later in this section.

6.1.1.2 TxDOT. In general, TxDOT should support agency staff to proactively champion ITS deployment efforts. Working with HGAC, TxDOT should promote and support cooperative deployment efforts and/or partnership opportunities among transportation stakeholders. They should also promote ITS deployment efforts at the TxDOT headquarters and federal agency levels. Finally, TxDOT should support the development of consistent ITS standards across the area and should assist in ensuring that the regional standards are consistent with State and national standards.

6.1.1.3 Harris County. Harris County should continue to be proactive in ITS deployment in the region. As a key stakeholder in TranStar, Harris County should work toward inter-jurisdictional coordination for traffic management and emergency management. The county could also serve as a model of ITS implementation for other counties in the region.

6.1.1.4 City of Houston. The City of Houston should take the lead in helping other municipalities establish ITS programs, including providing a model for integration with TxDOT traffic management activities. The City may also serve as an effective pool of potential project champions.

6.1.1.5 METRO. As the lead operator of majority of the transit related ITS applications, and as a major partner in TranStar, METRO is a key participant in the Houston Region intelligent transportation system. They should continue in this role, including working to insure continued coordination and where appropriate, integration, between transit and other portions of the ITS. Given their extensive experience in the area, METRO will continue to serve as a regional leader and source of practical experience in fleet management, including communications/dispatch and in the near future, with vehicle tracking. As an experienced operator of high-volume telephone traveler information services, METRO will also be an important component of the developing 511 system in the Houston Region.

6.1.1.6 Other Cities and Counties. There are numerous other agencies in the area which should play a key role in sponsoring ITS deployment. These agencies should provide project champions and participate in cooperative deployment efforts where appropriate. Many of the smaller cities in the area do not have the resources necessary for continuous involvement in ITS deployment. HGAC, TxDOT, Harris County and the larger cities should consider opportunities to assist deployment of systems in smaller cities as an adjunct to their larger deployments.

6.1.2 Deployment Champions

Deployment champions are individuals who have a political, professional, and/or personal interest in the deployment of certain ITS projects. Champions are critical to maintaining momentum and streamlining the deployment of ITS in the area. They provide a central knowledge base and continuous understanding of the particular deployments in which they are involved. They deal with project deployment issues both inside and outside of structured institutional environments. Taken as a whole, the deployment champions in the Houston region will comprise the core of ITS sponsorship and deployment support.

6.2 Qualities And Roles Of Deployment Champions

Each ITS deployment effort or project should have a designated champion who will see the project through from beginning to end. Ideally, champions should have the following qualities:

- Time to dedicate to the effort
- Support of their superiors
- Desire to see the system/project deployed
- Good communication and moderation skills
- Willingness to comprise on system/project details combined with the will to maintain the integrity of the system/project
- Basic understanding of the regional ITS vision and on-going architecture efforts
- Solid understanding of the system/project concept and how it will fit into existing operations

Promotional and mediation capabilities are more important qualities for a deployment champion than technical skill, as long as technical resources will be made available to support the champion. It is desirable for a champion to be supported by a subcommittee or even unofficial group of stakeholders in the project being deployed. However, while tasks may be distributed among members of a group to assist the champion, it is critical that an individual be the recognized coordinator of a deployment effort. The champion is the early project manager for an ITS deployment with the distinction that the project may not be fully conceptualized, funded, or designed. The champion must be a "jack of all trades." Champions should be prepared to focus their efforts in the following areas.

- System/Project Concept/Design – The champion should ensure that the system concept and design are in keeping with the needs for which the project was originally proposed and considered. The champion should establish a basic understanding of how the project fits into the regional ITS vision. Finally, the champion must be able to describe the basic project components or design considerations, although he/she need not be the most knowledgeable in these matters.

- Funding Applications – The champion should identify which timely funding sources may be available for deployment of the ITS system/project and aggressively pursue these sources. The large agencies with ITS experience, including TxDOT, City of Houston, Harris County and METRO, may be an excellent support resources for champions from smaller agencies or stakeholder groups.

- Inter-Agency Communication – The champion is responsible for maintaining consistent communication with agencies involved in the deployment of a system/project. ITS deployments will likely require the champion to gain local and area-wide support.

- Political Support – The deployment champion should identify the political support required to obtain funding and overcome institutional obstacles. The champion may need to aggressively argue their viewpoint to both internal and external political concerns in order to gain this support. Additional deployment champions from the political arena are often very effective in promoting deployment and overcoming obstacles.

- Agency Support – Some champions will be required to promote the project internally with their own agencies and organizations in addition to their external promotion efforts. Champions will have to seek substantial support from their organizations. This may include the identification of additional supporting champions from within the organization, as well as the recognition of the champions' time commitment to ITS deployment efforts by their organizations.

- Public Promotion – In addition to gaining and maintaining support from within the champion's organization at political levels, the champion will need to consider the application of public promotion activities. Most projects could benefit from some general promotion to the public that will inform them as to the purposes and benefits of the project. Potential use of web pages, flyers, and news articles/reports should be considered. If possible, the champion may seek the support of additional champions with good connections within communities that the project will benefit. Chambers of Commerce, economic development groups, and professional organizations are good sources of support.

- Regional Deployment Concept – The deployment champion should consider how and where his/her project fits within the larger regional ITS concept. Often a deployment champion may find other people promoting similar efforts within the area. Combining two or more geographically or functionally similar projects can often assist both projects in achieving deployment. The champion should also be familiar with other related projects in the area. The champion should consider, "Does the proposed system provide or receive information or resources from these projects?"

As a whole, the actions of deployment champions drive successful area-wide ITS deployment. An effort should be made to identify a clear champion for each of the projects described in Section 7.0

6.3 Arenas of Deployment Champion Involvement

When promoting deployment of ITS projects in the Houston region, deployment champions should understand four institutional arenas in which they may be involved. The level of involvement may vary from arena to arena and project to project, but generally some involvement in at least three of the four arenas will be required for successful deployment.

- Political Arena – comprised of local, regional, and national politicians and community leaders.
- Agency Executive Arena – comprised of transportation related agency executives at upper management levels with the authority to make decisions regarding staffing and funding concerns.
- Private Market Arena – comprised of private industry and organizations with a recognizable stake in the deployment of effective and marketable ITS services.
- Agency Staff Arena – comprised of agency middle management, technical, and support staff.

It is the job of the deployment champion to effectively utilize available resources in each of these arenas. It is likely that deployment champions will come from the agency staff arena, and that they will need to gain the support and championship of key individuals in the political and agency executive arenas.

- Political Arena – The champion should point out the public benefits of deploying the system/project, especially any benefits that may be easily promoted to the general public. The champions should seek to describe the project in simple terms that take into account the limited time and variable technical knowledge likely to be present in the political arena. It is ideal if the champion takes a few hours to develop a simple and brief presentation (five slides/five minutes) and project sheet that describe the key concepts of the deployment effort. It is often useful to have politicians participate in tours or visit similar systems deployed at other locations across the nation to generate political support for a deployment effort.
- Agency Executive Arena – The deployment champion should promote the regional benefits of the deployment. The champion should seek to discuss the deployment of the system/project in terms familiar with each executive. As with the political arena, initial presentations should be simple and brief, with further details and technical information being provided as requested. As with the political arena, the champion should try to get agency executives to visit sites with similarly deployed ITS systems. Tours of similar ITS deployments in neighboring areas or states are an effective means to display the ITS has real operational and resource benefits.
- Private Market Arena – The champion should determine the best role for the private market in the ITS deployment under consideration.

- Agency Staff Arena – The support of agency staff is critical to a champion being able to perform effectively. The champion should seek the support of stakeholding agencies' staff by pointing out the benefits to agency operations. The champion should work closely with agency staff to maintain open lines of communication.

6.4 Roles and Processes for Future System Architecture Conformity Assurance

The National ITS Architecture has evolved over the last approximately 8 years and is now in its third version. Until recently, use of an ITS system architecture, one consistent with the National ITS Architecture, was recommended by the USDOT, but not required. This changed in January 2001 with the joint publication of a Final Rule by the Federal Highway Administration (FHWA) and a Final Policy by the Federal Transit Administration (FTA). Table 6-1 summarizes the rule/policy.

The rule and policy, which are essentially the same, require that any ITS project funded in whole or in part by Federal Highway Trust fund money (which includes nearly all of the typical sources of Federal transportation funding, including the Mass Transit Account) be consistent with a regional ITS architecture, and utilize relevant USDOT-adopted ITS standards (none have yet been adopted). Compliance with the rule/policy is required by April 8, 2005, for regions, like Houston, that have or are deploying ITS projects. Certain ITS projects are exempted from the rule/policy. Until a regional architecture is in place, all major ITS projects must have a project level architecture. It is not intended that, once in place, a regional architecture answer all questions or necessarily dictate all specific ITS approaches. In fact, the rule/policy clearly state that modification of the regional architecture to accommodate a specific ITS project is permissible and to varying extents, to be anticipated. The architecture represents a flexible framework that will be come more specific and defined as individual project approaches are identified.

In order to avoid placing future federal ITS project funding in jeopardy, it is recommended that the Houston region consider development of a process to insure that, prior to the federal funding request, the relationship between specific local ITS projects and the regional ITS architecture is identified. This section identifies the direction that has been provided by the FHWA and FTA, and identifies considerations relative to developing an architecture consistency process for the Houston region.

<u>Federal Architecture Consistency Direction</u>

The FHWA rule and FTA policy on ITS architecture and standards does not mandate a specific local process, or local agency roles, in insuring that Federally funded ITS projects comply with the rule/policy. The rule/policy merely states that: (1) compliance will be self-certified by federal funding grantees, and (2) that monitoring of compliance will be done as part of normal oversight by FHWA/FTA.

Table 6-1: Highlights of Federal ITS Architecture and Standards Rule/Policy

<table>
<tr><td>Architecture Requirements</td><td>

If a region has or is deploying ITS projects, a regional ITS architecture must be developed by April 8, 2005, which is four years from the effective date of the Rule and Policy.
If a region has not yet deployed an ITS project, a regional ITS architecture must be developed within four years after its first ITS project deployment.
<u>Modifications to existing systems in order to conform with the National ITS Architecture are not required by the Rule and Policy</u>. It is anticipated that over time, however, regional ITS architectures will call for changes in existing legacy systems in order to support local desires for integration.
The regional architecture shall include, at a minimum, the following:

A description of the region;
Identification of participating agencies and other stakeholders;
An operational concept that identifies the roles and responsibilities of participating agencies and stakeholders in the operation and implementation of the systems included in the regional ITS architecture;
Any agreements (existing or new) required for operations, including at a minimum those affecting ITS project interoperability, utilization of ITS related standards, and the operation of the projects identified in the regional ITS architecture
System functional requirements;
Interface requirements and information exchanges with planned and existing systems and subsystems (for example, subsystems and architecture flows as defined in the National ITS Architecture);
Identification of ITS standards supporting regional and national interoperability; and
The sequence of projects required for implementation.

Prior to authorization of Highway Trust Funds, including Mass Transit Funds, for acquisition of implementation of ITS projects, compliance with the rule/policy will be demonstrated (in the case of the FTA Policy, it is specifically noted that grantees shall self-certify compliance). Compliance will be monitored under normal Federal-aid and FTA oversight procedures (in the case of the FTA Policy, to include annual risk assessments, triennial reviews, and program management oversight reviews as applicable).

</td></tr>
</table>

Table 6-1: Highlights of Federal ITS Architecture and Standards Rule/Policy (Continued)

Project and Policy Requirements	• Until a regional architecture is in place, all *major* ITS projects must have a project level architecture to ensure proper consideration of regional integration (a “major” ITS project is any ITS project that implements part of a regional ITS initiative that is multijurisdictional, multi-modal, or otherwise affects regional integration of systems.) • Once a regional ITS architecture is in place, all subsequent ITS projects must be designed in accordance with the regional architecture (i.e., accommodate the interface requirements and information exchanges specified in that architecture). • All ITS projects must be developed using a systems engineering approach. The systems engineering analysis shall include, at a minimum: - Identification of portions of the regional ITS architecture being implemented (or if a regional ITS architecture does not exist, the applicable portions of the National ITS Architecture); - Identification of participating agencies roles and responsibilities; - Requirements definitions; - Analysis of alternative system configurations and technology options to meet requirements; - Procurement options; - Identification of applicable ITS standards and testing procedures; and - Procedures and resources necessary for operations and management of the system. • The Final Rule/Policy requires that federally funded ITS projects use ITS standards adopted by the USDOT. As of August 2001 no standards have been adopted, although over 80 ITS standards are in development, and many are published. As a standard matures and is utilized by vendors and implementers, USDOT may decide to adopt it through a separate formal rulemaking process. • Any project that has advanced to final design by the effective date of the Final Policy/Rule (April 8, 2001) is exempt from the requirements relative to conformity to the regional architecture and use of standards. Some research projects and projects that entail an expansion of an ITS system in existence on the date of the enactment of TEA-21 may also be exempted from the Final Rule/Policy requirements.

The first Federal guidance document on compliance with the architecture rule/policy was issued by the FTA as a "working document" in October 2001 (the document is in the process of being issued as an FTA Circular). That document, ***"FTA National ITS Architecture Consistency Policy for Transit Projects"*** includes much useful information on overall roles and responsibilities. The report also includes additional information on the self-certification process to be followed by federal ITS fund grantees and the oversight process to be followed by the FTA. Although some of the guidance in the FTA document will apply only to FTA projects, much of the information will either also directly apply to FHWA projects, or is useful in identifying the general direction that will likely be taken by the FHWA. (The FHWA is currently working on an overall guidance document for developing, using and maintaining regional architectures but does not have a document equivalent to the FTA project-level guidance).

The following highlights the guidance presented in the FTA working document on architecture consistency for transit projects:

- Overall, grantee self-certification will follow the procedures and requirements established in the "FTA Master Agreement", and the "Annual List of Certifications and Assurances for Federal Transit Administration Grants and Cooperative Agreements". (pg. 4)

- In general, the Federal Role is to offer guidance and assistance on meeting the Architecture conformity requirements, though some oversight integrated with the normal FTA oversight procedures will also be carried out. The transit agency/grantee is responsible for working with it's regional partners to develop a regional architecture and meet the other project level requirements (e.g., agreements, systems engineering analysis). (pg. 6)

- ITS projects should be accounted for in FTA grant applications and procedures as the regional ITS architecture is developed and the projects move from planning to development and finally implementation. This includes:

  - Accounting for the Policy and other requirements in the FTA self certification, annual assurances and certifications, and Cooperative Agreements.
  - Incorporating Transit ITS activities into the Metropolitan Planning Program Grants and Urban Planning Work Program (UPWP) process
  - Including Transit ITS in the Transportation Plan (LRP), Transportation Improvement Program (TIP) and Statewide Transportation Improvement Program (STIP)
  - Documenting ITS projects and the status of policy conformity in FTA grant applications using TEAM.
  - Addressing Transit ITS in other Federal processes/requirements including the FTA Major Transit Investment (New Start) Process, the Congestion Mitigation and Air Quality (CMAQ) Program, the annual Federal ITS Service-Plan, and ITS Deployment Program Earmarks. (pg.19-20)

- A separate memorandum describing capturing ITS projects within TEAM (Transportation Electronic Award and Management) has been prepared and should be consulted for detailed guidance. In summary, grantees are expected to self-certify compliance with all requirements for ITS Architecture Conformity as described in TEA-21 and the FTA Policy, including status relative to conformity with a regional architecture and the type of ITS to be implemented: ITS Fleet Management, ITS Electronic Fare Payment, ITS Traveler Information, or ITS Architecture Development. (pg. 23)

- There are several FTA/FHWA programs that are likely to fund ITS projects and/or activities with specific procedures or regulations in addition to the general grant application requirements found in TEAM. These include:

  - Section 5309 Capital Grants, especially FTA Major Investment (New Start) Projects. It is important that the benefits and costs of the ITS elements be incorporated into the criteria calculation, the financial analysis, and the ability to implement and operate the ITS systems be part of the project management plan and PMO review. Transit agencies must work to fulfill both the New Start and ITS Conformity requirements for these projects. FTA Regional Offices must work to make agencies aware of the requirements, and to identify ITS elements within proposed New Start project early in their development.
  - The Congestion Mitigation and Air Quality (CMAQ) program.
  - The ITS Integration Program. Once the earmarks have been made each year specific guidelines are also issued by FTA/FHWA on how they should be further defined and submitted for approval. (pg. 24)

- Overall, the level of detail in documenting compliance with the Policy, and the level of oversight to be conducted by FTA, will vary depending on the scope of the ITS project. A major ITS project that requires the cooperation, agreement, sharing of information and data, and coordinated operations of several agencies will require much more analysis and supporting documentation, and will receive more oversight than one that is implemented within a single agency for its own use. Examples of efforts that may need more development, documentation, and analysis include:

  - A corridor or regional Transit Signal Priority System that operates in several municipalities, and on routes used by more than one agency;
  - An electronic payment system that will provide the first part of a regional electronic fare system, and later an integrated transportation payment system (tolls, parking and transit, etc.);
  - A coordinated communication backbone and radio system for the region that will provide shared communications for transit agencies, emergency service providers, and public safety agencies. (pg. 25)

- Examples of projects that must still meet the requirements, but may need less documentation are: a transit agency GIS and advanced scheduling system; an expansion of an existing AVL and computer aided dispatch system by the single transit agency in the region; a vehicle maintenance, or station security system. (pg. 26)

In addition to the above guidance, the FTA working document on architecture policy compliance identifies roles and responsibilities for major stakeholders, including the Federal Transit Administration, transit agencies/grantees, and other participants, including Metropolitan Planning Organizations. This information is presented in Table 6-2.

Table 6-2: ITS Architecture and Standards Rule/Policy Compliance: Stakeholder Roles and Responsibilities

Stakeholder	Roles and Responsibilities
Federal Transit Administration (Field and Headquarters)	• Become familiar with the Policy and its requirements • Establish roles, responsibilities, and communications channels among Regional staff, Headquarters, and other Federal partners (e.g. FHWA, FRA) for Policy support/oversight • Participate in applicable training • Ensure grantees, transit agencies, and other state and local entities: - Are aware and knowledgeable of the Policy/Rule, its requirements, and FTA/FHWA processes for their implementation - Understand the benefits of conformance with the ITS Architecture - Are aware of appropriate training and other available resources • Provide support to grantees/transit agencies at the **regional level** of ITS development. - Assist in assuring that grantees/transit agencies are aware of ITS activities in their region that may affect them. - Help assure that grantees/transit agencies have the opportunity to participate in regional ITS architecture development and are represented in other Federal efforts (e.g. service plan development, ITS Deployment (Earmark) project definition) as appropriate. - Provide coordination/facilitation among other grantees/transit agencies, State DOT's, other local operating entities, and other Federal offices as needed to ensure transit is represented, its interests are met and ITS regions are defined to account for transit service areas. - Identify regions that are "at risk" and provide oversight and review of regional architecture development through the planning certification, risk assessment, and other Federal oversight activities • Provide support to grantees/transit agencies at the **project level** of ITS development. - Assist grantees/transit agencies in resolving applicability of the Policy requirements. Is the project an ITS project or a Major ITS project? Do any of the applicability exceptions apply? What is the appropriate level of analysis and documentation? - Provide assistance in awareness/coordination/facilitation of other ITS activities and architectures that impact the project (parallel major ITS projects, state and inter-urban travel corridor activities). - Identify needs for oversight and technical assistance and training to successfully complete the project and conform to the Policy requirements. Assist in obtaining the required support.

Table 6-2: ITS Architecture and Standards Rule/Policy Compliance: Stakeholder Roles and Responsibilities (Continued)

Stakeholder	Roles and Responsibilities
	- Incorporate ITS oversight in FTA oversight activities to help identify grantees/transit agencies that are at risk and ensure compliance with the Policy. Review TEAM applications and Section 5309 New Start development efforts for ITS content. Include ITS in annual risk assessments, quarterly project reviews, triennial reviews and other efforts • Commit adequate staffing to accomplish the above
Transit Agency/ Grantee	• Become familiar with the Policy and its requirements • Ensure that agency staff are trained as necessary to understand how to meet the Policy requirements and successfully implement/operate the ITS components within their systems. • Participate in **regional** ITS activities including the development of the regional ITS architecture. - Work with all transit agencies and providers within the area to develop integrated and coordinated transit ITS systems as appropriate - Participate in the development of the regional ITS architecture and it's inclusion of all transit ITS components - Help define the ITS regional boundaries - Adopt inter-agency agreements to ensure the successful implementation and operation of the regional ITS architecture • Meet the **project** level requirements of the Policy - Identify the project's ITS elements and determine the Policy applicability (ITS Project, Major ITS Project, exempt). - Identify portion's of the regional ITS architecture, or if a regional ITS architecture does not exist yet, the National ITS Architecture, that are applicable. Identify other overlapping state and inter-urban corridor architectures that may be relevant. - Work to update architectures or develop a project architecture as appropriate. - Perform a Systems Engineering Analysis on the ITS components of the project - Include ITS project in TEAM grant submittal (description, and assurances) - Adopt inter-agency agreements to ensure the successful implementation and operation of the project's ITS components • Commit adequate staffing to accomplish the above

Table 6-2: ITS Architecture and Standards Rule/Policy Compliance: Stakeholder Roles and Responsibilities (Continued)

Stakeholder	Roles and Responsibilities
Other Participants (e.g. MPO, State, other organizations)	• Become familiar with the Policy and its requirements • Participate in applicable training • Work with grantees/transit agencies, Federal participants, and others to: - Determine regional boundaries acceptable to all stakeholders - Integrate transit and other stakeholders into ITS development procedures - Identify local champions and key participants for advancing/ implementing ITS - Identify roles and responsibilities for developing and maintaining the regional ITS architecture - Develop and establish processes and procedures for creating and maintaining the regional ITS architecture - Incorporate systems engineering analysis, ITS system sequencing, and need for agreements into project development and programming procedures - Perform continuous process review to refine procedures • Commit adequate staffing to accomplish the above

Source: *"FTA National ITS Architecture Consistency Policy for Transit Projects – Working Document"*, October 2, 2001, Federal Transit Administration, pg. 6-8.

6.4.1 "Straw Man" Houston Region Architecture Consistency Process

As specified by the FHWA and FTA, whatever approach is taken in the Houston region to ITS project consistency with the regional architecture will feature self-certification on the part of the project grantee. Although individual project sponsors will be required to demonstrate compliance, it is recommended that the Houston region consider development of a regional process that will facilitate that determination on the part of individual project sponsors, and help insure that the regional architecture remains viable as a planning tool. There are various approaches to such a process. One possible approach would feature HGAC as the facilitator, and would include the following four basic steps:

1. Project grantee planning stage consultation with HGAC – the project sponsor or grantee first consults with HGAC to determine:

a. Whether, and which of, the architecture rule/policy requirements apply:

- Is it an ITS project?
- Will it qualify for an exemption from the rule/policy?
- Will Highway Trust Funds be utilized?

b. Is the project included in the regional ITS architecture, and if not, should the architecture be revised, and how?; and

c. Given the scale of the project, what is the appropriate approach to the systems engineering analysis?

2. **Development of federal funding grant application and supporting rule/policy compliance documentation** – after making the appropriate determinations in the planning consultation with the HGAC, the grantee will complete the federal funding grant application materials, including rule/policy compliance documentation. HGAC will facilitate and assist in this process.

3. **Submittal of funding grant application**

4. **Project grantee design stage consultation with HGAC** – once federal funding has been secured for the ITS project and the design of the project is underway, the grantee will again consult with the HGAC, to:

   - Verify that the systems engineering process has been applied
   - Identify any changes in the project that have occurred since the planning consultation that warrant any changes to the regional architecture, or that warrant any other regional coordination.

The extent of HGAC participation in this straw man process, and the formality of the process, would likely vary depending on the grantee. The extent to which this process will be considered "mandatory", that it will constitute an "approval" process, is up to the regional ITS stakeholders to determine. The region may choose to view the process as advisory in nature and voluntary. Whether the federal funds are being distributed through HGAC, or received directly by the agency, could also impact the formality of the process. Overall, the objective is to avoid unnecessary "red tape" while insuring that the regional ITS architecture remains accurate.

For large agencies such as TxDOT and METRO that have extensive experience with Federal funding programs and that have the organizational resources necessary to support system architecture-related activities, HGAC would probably play a lesser role. For example, they would probably not be involved in development of the funding application (steps 2 and 3). Smaller agencies, on the other hand, may wish to rely more extensively on support from HGAC.

Regardless of the level of formality of the process or the extent of HGAC involvement, the key is that the regional architecture be consulted early in the project development effort, and again during the design stage, to insure consistency. Since this process will often entail revisions to the architecture, it is appropriate that the keepers of the regional ITS architecture—assumed to be HGAC—be involved in/informed of those consultations.

7.0 DEPLOYMENT CONCEPTS (PROJECTS)

This section shall present a variety of high-level deployment concepts based on the requirements analysis and the Regional ITS Architecture. The projects recommended have been categorized based on the functional/application area they fall under. Each of the projects described in this section will detail the following information (to the extent possible):

- Description of the concept
- Needs addressed
- Market packages incorporated
- Potential impacts
- Magnitude of costs

Table 7-1 lists all the potential projects listed by functional/application area. Detailed descriptions of each of the projects follows this table.

Table 7-1: Potential Projects Listed by Functional/Application Area

Functional/Application Area	Recommended Projects
Traffic Management	Project # 1: Expansion of Surveillance to Arterial Streets Project # 2: Expansion of CCTV and Sensor Systems on Freeways and Critical Areas Project # 3: Expansion of the RCTSS Project # 4: Arterial Street Traffic Detectors for the RCTSS Project # 5: Expansion of Incident Management Off Freeways Project # 6: Deploy and Integrate with Other Agencies Detecting Flood Conditions Project # 7: Expansion of Air Quality and Emissions Monitoring Project # 8: Establish Data Sharing Agreements and Formats Project # 9: Automate HOV Operations
Traveler Information	Project # 1: Deploy and Promote 511 traveler information System Project # 2: Marketing Effort for Traveler Information
Public Transportation	Project # 1: Enhance Transit Traveler Information with Real-Time Data
Emergency Management	Project # 1: Enhance Emergency Management Operations and Coordination
Electronic Payment	Project # 1: Regional Integrated Transportation Smart Card (Transit, Tolls, Parking, etc)
Commercial Vehicle Operations (CVO)	Project # 1: HAZMAT Identification
Maintenance & Construction	Project # 1: Smart Work Zones
Other	Project # 1: Enhance Agency to Agency Outreach, Coordination/ Communication

7.1 Traffic Management

7.1.1 Project 1: Expansion of Surveillance to Arterial Streets

Description of the Concept:

This project will implement, in a phased manner, closed-circuit television (CCTV) surveillance systems at major intersections and at other traffic accident or special event "hot spots" on arterial streets throughout the region. Surveillance systems are an essential building-block component of a broad range of traffic management strategies. Closed-circuit television cameras may be remotely controlled (panned, tilted and zoomed) to monitor real-time traffic conditions, including identifying and verifying traffic incidents. Typically, one CCTV camera covers one intersection, and can zoom as far as ½- mile in any direction.

Although much of the regional freeway system includes closed-circuit television camera coverage—and field reports from MAP operators—currently there is essentially no surveillance capability on arterial streets in the Houston region. Signal system operators' sources of information on current traffic conditions on arterial streets consist primarily of reports from motorists and law enforcement.

Traffic surveillance capabilities on major arterial streets are needed for a number of reasons. Arterial streets are a critical component of the transportation system—they carry heavy traffic volumes, and since they link freeways with local activity centers, nearly every trip includes travel on arterial streets. As is the case with freeways, in the face of increasing traffic volumes and reduced number of cost-feasible options for physical expansion, increased operational oversight and management of these facilities is necessary in order to squeeze as much capacity and throughput as possible out of existing and future investments.

Over the last 25 years, the notion of "managing" traffic conditions on freeways in real time has become widely accepted and practiced. Now, that recognition has spread to arterial streets, and jurisdictions around the country are implementing the backbone infrastructure—traffic detection, surveillance and traveler information—needed to support arterial street traffic management. Increasingly, traffic management is being conducted as a corridor activity, one that relies upon the ability to monitor current conditions on both freeways and arterial streets, and to coordinate traffic management strategies across these different types of facilities. Arterial street traffic management activities supported by arterial street surveillance systems include:

- Coordination of traffic detours from freeways onto arterial streets (both those coordinated by freeway system operators and the uncoordinated detours initiated by individual travelers).
- Coordination of special events like sporting events, concerts and holiday shopping.
- Coordination of traffic incidents, including incident identification and verification, modification of traffic signal timing plans, and providing information to emergency responders.
- Coordination of major construction projects (i.e., provide the ability to remotely monitor the effectiveness of traffic control measures, including special signal timing plans).
- In conjunction with centralized traffic signal control systems, increase the efficiency of traffic signal timing plan updates by providing the ability to remotely monitor plan effectiveness and impact of changes.

This project will include numerous phases, including:

Phase 1 – Regional Arterial Street Surveillance Concept Plan – although systems will be implemented and operated by local agencies, it is recommended that a high-level regional plan be developed in order to:

- Promote consistency and compatibility in approaches.
- Ensure that opportunities to coordinate activities, including sharing of video images and possible pooling of operations and maintenance resources, be adequately considered.
- Promote consistency with the regional ITS architecture.
- Encourage local jurisdictions to consider regional implications (including the timing of freeway and other arterial street projects) and priorities when setting their own priorities.
- Provide a mechanism for involving and supporting those local agencies that have not yet begun to consider the need for arterial street surveillance.

It is recommended that HGAC and TxDOT coordinate the planning effort, with each county and municipality providing the plan direction for their jurisdiction. The plan is recommended to be developed as a subcomponent of, or closely coordinated with, the Regional Arterial Street Incident Management Plan, described in a later project, since CCTV plays such an integral role in incident management. The surveillance system concept plan will identify a set of regional priority locations for arterial street surveillance implementation; a plan, based on the regional system architecture, for regional sharing of surveillance information and its utilization in the overall regional traffic management strategy; and guidance on technologies, installation, operations and maintenance.

The regional concept plan will be consulted by individual jurisdictions as they implement their local surveillance systems. In addition to informing local decisions, it is also possible that concept plan will result in the modification or addition of arterial street surveillance elements to planned freeway and arterial street projects.

It is recommended that this phase of the project be conducted soon, within the next several years, before too many local implementations have been made and before it is too late to establish some regional consistency and direction.

Phase 2 – Highest Priority Implementations – this phase will be the first of multiple implementation phases, and will focus on those locations identified as the highest priorities in the Regional Arterial Street Concept Plan. These locations are expected to include both those having regional traffic management significance (e.g., to support freeway-arterial corridor-level traffic management at key locations) and those that address localized issues. The implementation of the systems will be carried out by the local roadway operating agencies. During this first implementation phase, however, the status of implementation will be monitored closely at a regional level to insure that the coordination procedures and other strategies identified in the Regional Concept Plan are established. Regional oversight in latter implementation phases is expected to continue, but at a reduced level. It is likely that this first implementation phase will begin in the near future but will be spread out over many years, e.g., years 1-10.

Phase 3 – Other Implementations – this phase will implement additional arterial street surveillance systems at locations throughout the region. It is likely that this phase will be spread out over many years, e.g., years 10-20.

Needs Addressed:

- Improve Arterial Management

Market Packages Incorporated:

- Surface Street Control
- Regional Traffic Control

Potential Impacts:

Primary benefits associated with this project include the following:

- Reduce ***accident severity*** by facilitating more effective incident management, e.g., by quickly identifying exactly what equipment and personnel is needed and providing this information to incident responders.
- Reduce ***secondary accident frequency*** by facilitating more effective incident management (e.g., by providing information to support traffic detours and traveler advisories and by speeding incident clearing).
- Reduce ***vehicle delay***, and associated ***fuel consumption*** and ***emissions***, associated with traffic incidents by facilitating more effective incident management and a quicker return to normal traffic flow conditions.
- Reduce ***vehicle delay***, and associated ***fuel consumption*** and ***emissions***, by supporting more efficient (and therefore more frequent) and more effective modifications of traffic signal timing plans (surveillance provides the ability to remotely monitor the need for, and effectiveness of modifications, as an alternative to labor intensive field work), in response to: overall traffic growth, construction, special events and incidents.

Magnitude of Costs:

The cost of Phase 1, development of the Regional Arterial Street Surveillance Concept Plan is estimated at $100,000.

The costs to deploy the surveillance systems, Phases 2 and 3 will vary depending on the number of locations and the presence/absence of supporting legacy infrastructure. Major cost components of an arterial street surveillance system include:

- Camera enclosure
- Pole – will typically utilize existing traffic signal poles at signalized intersections, but not all existing poles may be suitable. New poles typically required at non-intersection locations.
- Controller – will typically utilize the same controller as used for the traffic signal at signalized intersections. Not all existing controllers will support the cameras so new controllers may be necessary.
- Local communications – links the device to the controller and the controller to the backbone (long-haul) communications.
- Backbone (long-haul) communications – transmits camera images to a remote monitoring location and control commands from the remote monitoring location to the camera. If a centralized traffic signal system is in place (allowing communication from individual controllers to a remote location), and if cameras will be monitored from the

same location as the signals are controlled from, then the camera system may utilize the signal communications link.

- Fixed-end equipment – monitors and communications and computer hardware and software (multiplexors, etc.) needed to process and view the camera images and control the cameras.

The typical cost for the field infrastructure (camera, mounting, controller, local communications) will vary from approximately $20,000 to $50,000 per location, depending on use of existing mounting and communications infrastructure. If Phase 2 includes 100 locations, and four jurisdictions at a cost of $250,000 per jurisdiction (assuming each requires substantial fixed-end investment but that existing backbone communications systems can be used), and assuming 30 percent for combined design and contingency, the cost of Phase 2 could be in the area of $7 million.

7.1.2 Project 2: Expansion of CCTV and Sensor Systems on Freeways and Critical Areas

Description of the Concept:

This project will implement additional closed-circuit television (CCTV) surveillance cameras and traffic detectors on regional freeways. Although large portions of the regional freeway system currently include CCTV and detector coverage, many key locations, including both mainline segments, on and off-ramps and the intersections of on/off ramps with local streets, do not include coverage. This project will significantly expand the geographic extent of the TranStar regional freeway management system, which has proven to be an effective tool.

Additional CCTV and traffic detectors will allow TranStar to monitor traffic flow in real-time, identify and verify traffic incidents, and provide a valuable source of on-scene information that can be used to coordinate incident management efforts, and support public travel advisories. Cameras and sensors at ramp locations are especially important in coordinating freeway and arterial street traffic management, such as part of a corridor traffic management strategy. This type of coordination including managing the impact of queues at on-ramp meters and the impact of freeway traffic diversions, both those orchestrated by TranStar and the large scale spontaneous diversions associated with major traffic incidents.

In mainline freeway applications, comprehensive CCTV coverage can typically be provided at least ½-mile spacing and at critical locations, and typical traffic detector coverage would also be at ½-mile spacing, with additional detectors used at interchanges.

This project includes two primary phases. The first phase consists of the development of an overall plan to guide CCTV and sensor deployment, including identification of locations and phasing, as well as preliminary engineering and design. The second phase will implement the new CCTV and sensors, and may itself include numerous phases. Design will utilize the standard designs and specifications as established to date through the regional freeway management system deployment.

Surveillance and detector systems generally include three main components: the devices themselves and the computers located in the field that control them; communications links (between the devices and the controller and between the controller and a monitoring location) and the fixed-end equipment located at the monitoring location (includes communications and computing hardware and software). For the most part, this project will focus on the field devices themselves, their field controllers and local communications. The bulk of the fixed-end infrastructure is already in place at the TranStar Traffic Management Center, although some additional equipment may be necessary. Also, in most cases, much of the backbone communications link connecting the new devices to TranStar (the regional fiber optic communications system) is in place. In locations not served by the backbone fiber system, point-to-point wireless communications may be utilized to link to the closest fiber node.

Needs Addressed:

- Improve Arterial Management
- Improve Incident Detection and Management
- Mitigate Congestion on Interstates and Arterials

Market Packages Incorporated:

- Network Surveillance
- Freeway Control
- Surface Street Control

Potential Impacts:

Applied within the context of an overall traffic management strategy, the additional CCTV and sensors will result allow operators to more quickly identify and clear traffic incidents, resulting in ***reduced vehicle delay***, including associated reductions in ***fuel consumption*** and ***emissions***, and ***reduced accident severity*** and/or a ***reduced number of secondary accidents***.

Magnitude of Costs:

The cost of this project will depend on the number of each type of device to be deployed and the extent to which legacy infrastructure can be utilized, including mounting poles/structures, controllers and communications. The typical per location cost of CCTV field equipment varies from approximately $20,000 to $50,000. The typical per location cost of traffic detector field equipment (assuming inductive loops) ranges from $5,000 to $10,000 per detector. So, for example, if this project includes 100 of each device, the total cost for field infrastructure could range from $2.5 to $6 million.

If additional fiber optic cable is utilized, typical installed costs for the fiber and its related components (conduit, hand holes, man holes, junction boxes, etc.) are approximately $100,000 per mile. The costs of wireless equipment vary depending on bandwidth, manufacturer and other considerations. Typical costs for a pair of antennae and radios ranges from $8,000 to $22,000. Potential interference, line of sight, and mounting (e.g., ability to pole mount or construct a tower) are among the issues that must be considered when pursuing a wireless communications solution.

7.1.3 Project 3: Expansion of the RCTSS System

Description of the Concept:

This project will integrate additional traffic signals into the Regional Computerized Traffic Signal System (RCTSS), which is now in development. This project focuses on fixed-end (i.e., the computer hardware and software located at traffic signal control rooms) and communications elements of RCTSS; Project 4 implements the additional arterial street traffic detectors needed to support RCTSS operations in the expanded areas. Currently, the system is being implemented to be able to support approximately 3,000 traffic signals. This project will fund the integration of additional traffic signals into the RCTSS.

Including traffic signals in the RCTSS provides operators the ability to monitor signal operations, including automatic monitoring of malfunctions, from a remote location, and to remotely make changes in signal timing operations, including implementing new timing plans, uploading current plans stored in the local traffic signal controllers, and accessing the timing plan currently in use at a given location. Centralized systems like the RCTSS also provide the ability to enable traffic signal preemption for emergency vehicles and signal priority for transit vehicles. By including all of the signals within a single system, the ability to coordinate signals across jurisdictional lines and to coordinate responses to incidents is greatly enhanced. In the case of the RCTSS, Houston TranStar will utilize the system to modify signal timing plans in response to congestion, incidents and special events.

The existing RCTSS development effort will provide for the fixed-end (TranStar) hardware and software, and therefore the integration of additional agencies' traffic signals into the RCTSS will consist primarily of installing communications linkages between the new signals and the RCTSS back office equipment at TranStar. A combination of various communication technologies is currently being used to support the initial RCTSS implementation, including fiber optic cable, copper wire and wireless (Cellular Digital Packet Data). The specific type of communications implemented as part of this project will likewise vary, depending on the locations of the new signals and opportunities to utilize existing communications resources.

Needs Addressed:

- Improve Arterial Management
- Improve Traffic Signal Operations

Market Packages incorporated:

- Surface Street Control
- Regional Traffic Control

Potential Impacts:

This project will ***reduce vehicle delay***, and associated ***fuel consumption*** and ***vehicle emissions***, by providing operators the means to efficiently modify traffic signal timing plans to meet varying conditions, including exceptional congestion, traffic incidents and special events, and to better coordinate adjacent traffic signals. Also, by providing the means to modify signal timing plans remotely, this project will ***improve the efficiency*** of signal timing plan implementation. Finally, the project will ***increase safety*** by providing for automatic monitoring and nearly instantaneous notification of traffic signal malfunctions.

Magnitude of Costs:

The primary costs are those associated with the communications infrastructure linking traffic signals in the field with the RCTSS control room. Communications costs will vary depending on the type of technology utilized, which will vary depending on the location of the signals and the availability of existing communications infrastructure, and the number of signals to be integrated.

The average cost per intersection for equipment (e.g., controllers and communications), with some minor improvements, is $30,000, installed. The type of communications utilized will vary depending on the type of connection and the distance to the nearest network access point.

7.1.4 Project 4: Arterial Street Traffic Detectors for the RCTSS

Description of the Concept:

This project provides the additional traffic detectors that will, in some cases, be needed to support the integration of additional traffic signals into the Regional Computerized Traffic Signal System (RCTSS). Project 3 implements the fixed-end (i.e., the computer hardware and software located at traffic signal control rooms) and communications elements needed to support expansion of the RCTSS.

Integrating traffic signals into the RCTSS provides the capability to monitor traffic signals and make changes in timing plans in response to congestion, incidents and special events, all from a remote location. The traffic signal operating strategies typically associated with centralized traffic signal control, such as that provided through the RCTSS, rely upon data collected from traffic detectors located on each intersection approach. This project provides funding to add or replace traffic detectors as necessary at various intersections to support the integration of those locations into the RCTSS.

Needs Addressed:

- Improve Arterial Management
- Improve Traffic Signal Operations

Market Packages Incorporated:

- Surface Street Control
- Regional Traffic Control

Potential Impacts:

The traffic detectors implemented in this project are a prerequisite to effective operation of traffic signals through the RCTSS. As such, the primary benefits of this project are those associated with the RCTSS, which will ***reduce vehicle delay***, and associated ***fuel consumption*** and ***vehicle emissions***, by providing operators the means to efficiently modify traffic signal timing plans to meet varying conditions, including exceptional congestion, traffic incidents and special events, and to better coordinate adjacent traffic signals. Also, by providing the means to modify signal timing plans remotely, the RCTSS will ***improve the efficiency*** of signal timing plan implementation. Finally, the RCTSS expansion project will ***increase safety*** by providing for automatic monitoring and nearly instantaneous notification of traffic signal malfunctions.

In addition to enabling traffic signal operation through the RCTSS, the traffic detectors implemented in this project provide a means to efficiently collect traffic volume information, both in support of special projects and as part of a traffic counting program.

Magnitude of Costs:

The costs to deploy traffic detectors at intersections will depend on the number of detectors required, a function of whether any sensors currently exist, and their condition, and also of the traffic signal control strategy being pursued (different strategies have varying traffic data requirements). Implementation of an inductive loop traffic detector—the most common type of traffic detector used in the Houston region—typically costs less than $5,000 per detector. Therefore, for an intersection of two two-lane roads, installation of a loop in each approach lane (for a total of 8 loops) would cost no more than $40,000.

7.1.5 Project 5: Expansion of Incident Management Off Freeways

Description of the Concept:

This project expands the incident management activities currently utilized on area freeways onto the major arterial streets that feed the freeways. The incident management infrastructure implemented in this project can also be used in support of day-to-day arterial street traffic management. The freeway incident management program is designed to speed the detection and clearance of incidents, thus reducing incident-related congestion, delay and secondary incidents. The freeway incident management program features fixed field infrastructure, motorist assistance patrols, a central control center from which activities are directed and coordinated (TranStar Traffic Management Center), and supporting agreements among agencies identifying roles, responsibilities and procedures. This project will feature the phased expansion of many, if not all of these elements, onto key major arterials.

Throughout the United States, and in the Houston region, freeway incident management programs have emerged as among the most successful ITS strategies, both from operator and traveler perspectives. By providing a real-time monitoring capability, mechanisms for faster incident clearance, and the means to quickly advise motorists of incidents, these programs allow operators to minimize the impact of traffic incidents—incidents that are seemingly inevitable and which create such massive delays and safety hazards on a daily basis. Increasingly, the need for and benefit of practicing incident management on major arterial streets is becoming apparent. Arterial streets play a key role in nearly all trips. Incidents and delays on arterial streets can impact travel times just as adversely as those on freeways. The expansion of incident management onto key arterial streets—those feeding the freeways—is a natural progression and an appropriate response to traveler needs.

This project will expand MAP to key arterial street segments, and implement dynamic message signs scaled for arterial street applications. Other critical components in a multi-faceted arterial street incident management system include CCTV surveillance cameras, vehicle detectors and centralized traffic signal control. Those elements are implemented through Projects 1, 3 and 4, respectively.

Phase 1 – Develop Regional Arterial Street Incident Management Plan – the implementation of arterial street incident management will be phased geographically (i.e., starting with key locations and known incident hot spots) and most likely also by component (e.g., not all of the program components will be put into place at the same time in any given location). The first phase of this project will develop a regional plan that identifies the initial set of high priority deployment locations and which identifies the overall framework for region wide expansion of the program, including components and their typical phasing, and institutional roles, responsibilities and specific procedures. Development of the plan should include all of the agencies that may participate in the program, including the TranStar partners and agencies responsible for local street operations.

This plan should include as a subcomponent, or be closely coordinated with the development of, the Regional Arterial Street Surveillance Concept Plan described in an earlier project. Phasing of this project should also consider the timing of implementation of traffic signal related infrastructure and capabilities associated with Projects 3 and 4, which provide for centralized traffic signal control, an important part of arterial street incident management. The planning of this project should also consider the results of current efforts to develop arterial street management in flood prone areas. The description of arterial street incident management activities in the regional system architecture should be updated, as needed, based on the results of the plan. The plan results can also be included in the regional long-range transportation plan.

Phase 2 – Highest Priority Locations – this phase will be the first of multiple implementation phases, and will focus on those locations identified as the highest priorities in the Regional Arterial Street Incident Management Plan. These locations are expected to include both those having regional traffic management significance (e.g., to support freeway-arterial corridor-level traffic management at key locations) and those that address localized issues. It is likely that the first implementation phase will begin in the near future but will be spread out over several years, e.g., years 1-5. Also, during this initial implementation phase, agencies responsible for arterials shall establish a work station, or share a work station location, on the TranStar operations floor.

Phase 3 – Other Implementations – this phase will expand arterial street incident management to additional locations throughout the region, and will be spread out over years 5 through 20.

Needs Addressed:

- Improve Incident Detection and Management

Market Packages Incorporated:

- Incident Management System

Potential Impacts:

This project will allow operators to more quickly identify and clear traffic incidents on, or impacting, major arterial streets feeding freeways, and to provide travelers with information that will allow them to avoid, or better prepare for, incident scenes. This will result in ***reduced vehicle delay***, including associated reductions in ***fuel consumption*** and ***emissions***, and ***reduced accident severity*** and/or a ***reduced number of secondary accidents***.

Magnitude of Costs:

The costs of this project will vary depending on the number of locations that are selected and the specific incident management elements to be implemented at various locations. At some locations, through coordination of this project with Projects 1, 3 and 4, the CCTV, traffic detectors, signal controllers and communications components of arterial street incident management infrastructure will be provided. In these cases, additional field infrastructure will be limited to dynamic message signs, and their controllers and communications. The estimated cost for those elements is $50,000 per location. In cases where CCTV and traffic detectors, along with their controllers and communications, are also to be implemented through this project, the cost of CCTV is estimated at $50,000 per installation, and traffic detectors at $2,000 per detector. Costs associated with expansion of the MAP coverage to arterial street freeway approaches include the costs of additional vehicles and personnel labor hours. A conservative estimate for a new, fully equipped MAP vehicle is $50,000 with labor costs in the range of $55,000/yr/shift.

Given these estimated unit costs, an implementation cost can be identified for a hypothetical deployment scenario. For illustrative purposes, the following scenario is assumed:

- The deployment focuses on the 1-mile arterial street approaches to freeway interchanges, in either direction, at 20 key locations, for a total of 40 miles of arterial street.
- Each 1-mile arterial street approach segments is assumed to include three (3) traffic signals, one at the on/off-ramp, and two upstream, for a total of six (6) signals per location (3 on either side of the freeway), and a total of 120 signals for the project.
- Two (2) additional traffic detectors are required per approach at the 120 signalized intersection locations (or, the detectors may be used at mid-block locations or at the upstream intersections), for a total of 960 detectors.
- One DMS and one CCTV unit are deployed on each arterial street, on each approach leading to the freeway, for a total of 40 DMS and 40 CCTV.
- Additional MAP coverage associated with these locations requires an additional two (2) vehicles.
- The CCTV and traffic detectors associated with half of the 20 locations will be provided through Projects 1, 3 and 4 and are not included in this project cost estimate. After subtracting those components, this project includes 20 CCTV and 480 traffic detectors.

The total estimated implementation cost for this hypothetical 20-interchange scenario, which includes two new MAP vehicles, 20 CCTV, 40 DMS and 480 traffic detectors, is approximately $4.7 million. That cost includes design and contingency, estimated at a total of 30 percent of total capital costs.

7.1.6 Project 6: Deploy and Integrate With Other Agencies Detecting Flood Conditions

Description of the Concept:

This project will expand the regional system of flood sensors by implementing additional flood-sensing devices at key locations on area freeways and arterial streets. This project will also, integrate the new sensors so as to allow data to be shared among agencies and to be utilized for various applications. The new flood sensors on the freeway and arterial streets will compliment the traffic detectors and surveillance cameras currently deployed on many portions of the regional freeway system, and to be deployed at key arterial street locations, providing traffic managers another source of real-time information on traffic conditions, upon which they may base their traffic and incident management decisions. The addition of the freeway and arterial street sensor data to the current regional, multi-agency network of sensors will make the regional system more complete and useful.

This project will include a number of components, including:

- Identifying and prioritizing locations for new roadway flood sensors.
- Developing a phased implementation plan for implementation of new sensors
- Installing the new sensors.
- Implementing the fixed-end equipment, including computer and communications hardware and software, at the TranStar Traffic Management Center, necessary to monitor the sensors, and access the regional sensor network.
- Implementing the communications elements necessary to link the individual sensors with the regional sensing network and the TranStar Traffic Management Center.

It is recommended that this effort be led by the regional traffic management agencies and coordinated closely with those agencies responsible for the regional flood-sensing network, including Harris County and the City of Houston Office of Emergency Management. The identification and prioritization of sensor locations on the freeways and arterial streets, as well as the selection of technologies and design of the installations, should be made by the roadway operators, but with the input of those with specialized expertise in flood sensing and related issues.

On portions of the freeway and arterial street system that currently include traffic management system infrastructure, including backbone communications, power supply and controllers, the addition of the flood sensors will be relatively simple. In locations where no backbone communications or power supply is currently deployed, the installation of the sensors will be more involved and costly. It is expected that the identification and prioritization of roadway flood sensor locations will take into account these issues, as well as the obvious topographical considerations. For any critical locations that are not yet served by the fiber optic backbone system, or some other landline backbone, alternative communications options are possible, e.g., wireless.

At TranStar, monitoring of the freeway flood sensors may utilize the same hardware and software system as utilized by other regional agencies to monitor the regional flood sensor system. If cost-feasible, it may be desirable to link that monitoring system with the traffic and incident management system software and user interfaces, to avoid creating another source of information that must be monitored and to allow flood alerts to be displayed directly to the TranStar operators from within their existing software.

Needs Addressed:

- Improve and Expand the Scope of Flood Monitoring Systems
- Enhance Emergency Response

Market Packages Incorporated:

- Road Weather Information System (version 3.0 of the architecture)
- Road Weather Data Collection (version 4.0 of the architecture)
- Flood Level Reporting (Aux)

Potential Impacts:

The freeway flood sensors will allow TranStar, or other traffic and emergency management centers, to anticipate hazardous conditions as they develop, and to close roads, suggest alternate routes to travelers, or advise travelers to be prepared for hazardous conditions and delays. These activities, by reducing the volume of traffic into flooded areas and by making travelers approaching these areas more alert, should ***reduce the number and/or severity of incidents*** and ***reduce the traffic delays*** associated with congestion and incidents in flooded areas.

Magnitude of Costs:

The costs to implement the freeway flood sensors will vary depending, obviously, on the number of sensors and their location, which will vary in terms of the availability of power supply, backbone communications infrastructure and traffic device controllers (which may or may not also be used to interface with the flood sensors). In addition to the cost of field equipment, there will be costs associated with the fixed-end software and systems integration that will allow TranStar to monitor freeway flood sensors.

The costs of individual flood sensor installations vary from approximately $10,000 to $50,000. Assuming that 20 freeway flood sensors are installed at $20,000 per location (includes only the sensors and local communications links; backbone communications to be provided through freeway management system infrastructure), and allowing for approximately $250,000 for fixed-end hardware, software and integration, and 30 percent for planning, design and contingency, the total cost of this project would be $845,000.

7.1.7 <u>Project 7: Expansion of Air Quality and Emissions Monitoring</u>

Description of the Concept:

This project will expand and enhance the current regional air quality and emissions monitoring activities carried out by the TCEQ and the Harris County Office of Environmental Management. This project includes implementation of additional sensors in other portions of the Houston region.

Air quality is a concern in the Houston region. A comprehensive and reliable network of air quality and emissions sensors is a fundamental enabling component of an effective air quality regulatory compliance strategy—a goal that directly impact public health and which impacts the availability of Federal transportation funds. Data from air quality sensors throughout the region provide the basis for public health advisories, enable more accurate air quality modeling and planning, and are the trigger for promoting travel demand management strategies on the part of transportation agencies and major employers. The current coverage of air quality sensors throughout the Houston region is inadequate; additional sensors are needed to fill many gaps and extend coverage into completely uninstrumented areas.

In addition to funding additional air quality and emissions monitoring sites, this project will provide funding to increase the testing, calibration and other maintenance necessary to insure the validity of information provided by existing sites.

New monitoring sites include the air quality sensors themselves and their mountings, power supply, and communications to transmit the information back to a centralized location. Generally, low band-width/slower speed communications infrastructure, such as telephone lines, is sufficient.

This project will include a number of components, including:

- Identifying and prioritizing locations for additional monitors
- Developing a phased implementation plan for implementation of new monitors
- Installing the new monitors
- Implementing the communications elements necessary to link the individual sensors with the regional air quality monitoring network

This effort will be led by the operators of the regional air quality monitoring network.

Needs Addressed:

- Ensure Air Quality Compliance

Market Packages Incorporated:

- Emissions Monitoring and Management

Potential Impacts:

The additional data provided through the air quality and emissions sensors implemented in this project will ultimately lead to ***improved air quality*** and ***public health***. The additional data will support better planning and improve the effectiveness of air quality strategies by providing a more comprehensive picture of air quality conditions, and an improved ability to focus in on localized hot spots. In cases where hot spots are created primarily from vehicular emissions, this information may support transportation improvements to reduce delay. The more comprehensive data will also support better public air quality advisories.

Magnitude of Costs:

Assuming that this project implements 10 new air quality and emissions monitors at an average cost of $25,000, assuming an additional 30 percent of those capital costs for planning/design/ contingency, and providing an additional $100,000 to test and repair/calibrate existing sensors as necessary, the estimated cost of this project is $425,000.

7.1.8 Project 8: Establish Data Sharing Agreements and Formats

Description of the Concept:

This project will develop agreements and formats to support sharing of data among TranStar agencies and those who are beginning to deploy ITS. Data sharing defines the middle level of the evolutionary, three-phase information sharing and integration hierarchy and is prerequisite to higher levels of mutually dependent coordination. The ability to respond to transportation challenges in a coordinated, multi-agency, multi-jurisdictional manner is one of the primary benefits of ITS investment and sharing of key data among agencies is a critical component of coordinated strategies. Examples of data sharing that support ITS objectives include sharing incident CCTV images among various traffic, transit, emergency response and traffic reporting organizations, sharing of traffic signal timing plan information among traffic signal operating agencies, and sharing of transit vehicle location between the transit agency and law enforcement agencies (e.g., in the case of on-board transit emergencies).

The first phase of this project will identify key data flows among organizations and establish agreements among agencies governing those data flows. The identification of key data flows will be based on the Houston Region System Architecture, and guided by Sections 5.1, 5.2, 5.3 and 5.6 of this Strategic Plan, which identify basic roles and responsibilities, the integration and information sharing hierarchy, and the use of standards in support of data collection, format and exchange. As part of this exercise, the need and timing of different types of data will be differentiated, e.g., "critical – needed to support current operations", "needed to support near term operations", etc. The data sharing agreements will formally pledge the agencies' commitment to share specific types of data, and identify the intended uses of the data, including limitations and restrictions, such as those related to privacy, security, liability and ownership.

The second phase of this project will identify specific data formats for the data types identified in the first phase. In order for data to be useful to multiple agencies, each agency must have the ability to receive, display, and in some cases process, the data. Identification of a single, regional format for specific data does not in itself insure that different agencies will be able to utilize the data, but it does provide those agencies a clear basis for configuring their systems so as to accept the data. This effort will focus first on those data types that are identified in the first phase of this project as being critical to current and near term operations.

This project should be carried out through a regional ITS committee or task force, facilitated by the HGAC. Retention of a qualified consultant may be desirable to support the project.

Needs Addressed:

- Improve Agency Coordination
- Improve Data warehousing and Management

Market Packages Incorporated:

- ITS Data Mart
- ITS Data Warehouse

Potential Impacts:

This project will promote the ***coordinated planning, design, implementation and operation of Intelligent Transportation Systems*** in the Houston region and therefore will support a wide range of benefits that will result from the successful coordinated operation of ITS projects. Sharing of data among organizations is especially important in areas such as incident management, and a data sharing capability will directly improve the ability to coordinate. For example, providing video images to emergency responders will allow them to quickly identify the specific equipment and personnel that needs to be sent to a scene, thus saving time and avoiding an over-response (i.e., sending more equipment than is necessary), which saves money and avoids undue traffic impacts.

Magnitude of Costs:

This project will be carried out as a regional committee or task force effort, with various organizations participating. If a consultant is retained to support this effort, the estimated cost of the consultant contract is $100,000.

7.1.9 Project 9: Automate HOV Operation

Description of the Concept:

This project will automate signage, lane and gate control for the reversible-barrier separated High Occupancy Vehicle (HOV) lane system in the Houston region. Replacing current manual operation with automated operation will improve productivity and improve safety.

The existing system, nearly 100 miles of roadway, consists of HOV-only lanes located within the median of freeways, separated from the regular lanes on either side by a concrete barrier. At any given time, the lanes only allow travel in one direction, e.g., in the direction of the predominant traffic flow for a particular time of day. The allowable direction of travel changes for the AM and PM peak periods. Access to the lanes is controlled by raising and lowering gate arms at the HOV system access points. Currently, this process is accomplished manually, on site at each gate location. This project will automate that process by providing the means to remotely (e.g., from the TranStar Traffic Management Center and potentially other locations) raise and lower the gates at access points.

Automation of devices will save the time and effort associated with the field visits currently needed to configure the ramps, and the remote control capability will also provide the ability to monitor the status and functioning of devices remotely, which will improve safety.

The components of this project include a study/design phase that will include the systems engineering analysis required by the FHWA for ITS projects. That analysis will include consideration of phasing issues, address the relationship of the project to the regional system architecture (and identify needed modifications in the architecture and/or the project), identify a technology solution, develop operating procedures, and develop the detailed design for the system. A second phase of the project will implement the improvements.

METRO is currently in a preliminary stage in investigating the feasibility of automating the HOV lane system. Future efforts to further develop and implement this project should be coordinated with METRO's work in this area.

Needs Addressed:

- Improve Existing HOV Lane Management

Market Packages Incorporated:

- HOV Lane Management

Potential Impacts:

This project will improve the safety and efficiency of HOV lane operations. Specifically, the labor expense associated with field activation of the individual gate arms will be eliminated and automated monitoring of gate arm status and operation will improve safety.

Magnitude of Costs:

The cost of the study/design phase of the project, to include system requirements, preliminary engineering and design, is estimated at $550,000. Construction is estimated at $15 million. This includes:

- Gates, lane control signals, DMS, local communications, controllers and cabinets at all "T" and slip ramps.
- Central and field software.
- Central hardware.

7.2 Traveler Information

7.2.1 Project 1: Deploy and Promote a 511 Traveler Information System

Description of the Concept:

This project will establish a single, three-digit telephone number—"511"—that can be used anywhere in the region to access multi-modal traveler information. The 511 number has been reserved by the United States Department of Transportation for this purpose and many jurisdictions around the country have implemented, or are in the process of implementing local 511 services. This project will make it easier for travelers to access information which should improve their travel planning decisions, for example, help them to avoid or prepare for delays.

One of the initial focuses of the 511 effort will be to convert the existing statewide, toll free "Texas Travel Information System" phone service (800-452-9292), the Texas District Information Hotline (713-802-5074) and the regional METROLine transit information hotline operated by METRO (713-635-4000) to the 511 number. Additional phone numbers can be added to the 511 system over time, both in the form of conversions or links from existing services (e.g., other local transit customer service numbers) and by the creation of entirely new services. Also, data currently posted on the TranStar web page would be available on the 511 system via a text-to-speech translation.

A study of 511 implementation has already been conducted and has recommended an approach.

Conversion of existing phone services to landline 511 operation is relatively straightforward, and consists of paying the phone company to reprogram their switches. Establishing 511 access via cell phones is much more complicated, since there are many, many companies providing service within the Houston region. Separate negotiations with each cell phone provider are required. Around the country, most cell phone companies have cooperated with 511 system developers, although in the case of a few companies and a few locations, there have been difficulties. Involvement of telecommunications providers in the planning effort, along with the state telecommunications regulatory authority is highly recommended.

The implementation of 511 will also include a marketing/promotional effort to inform the public about the new service. This effort will include working with the media, development of brochures and web site materials, and installation of traveler information hot line signs on freeways.

Needs Addressed:

- Provide Better Traveler Information

Market Packages Incorporated:

- Interactive Traveler Information

Potential Impacts:

The primary benefit of this project will be to make it more ***convenient*** for travelers to obtain travel information. Experience with 511 systems around the country has been that conversion of existing 10-digit numbers to the simple 511 number results in large increases in call volume. To the extent to which highway travelers utilize that information to avoid or better prepare for delay, accidents and adverse weather, the 511 system will contribute to improved ***safety*** and ***reduced delay***. The 511 number will also significantly diminish one of the traditional barriers to ***transit ridership*** by making it very easy to obtain route and schedule information by phone.

Magnitude of Costs:

The cost to develop and deploy the 511 system will range from $200,000 to $300,000 with recurring costs of approximately $50,000/year.

7.2.2 Project 2: Marketing Effort for Traveler Information

Description of the Concept:

This project will promote traveler information resources to the public with the objective of increasing awareness and utilization of existing sources (e.g., TranStar regional traveler information web site, email notifications, paging system) and new sources (e.g., the regional 511 system). Marketing is a critical component in the success of traveler information systems, which, when well-utilized, can reduce driver frustration and reduce accidents and delays by providing travelers with the information they need to avoid congested and higher risk areas.

The first phase of this project will consist of developing a current Action Plan for Regional Traveler Information System Marketing. This effort will include review of existing traveler information strategies and promotion efforts, including assembling and reviewing al information collected to date regarding the use and effectiveness of those resources and efforts. Based on this review, a plan will be developed that lays out specific objectives, expectations, an action item list of specific marketing activities and organizational responsibilities, and a process for evaluation of the effectiveness of future efforts.

Specific traveler information marketing activities that will be considered in the development of the Action Plan include:

- Media advertisements (print and broadcast)
- Printed promotional materials
- Exhibits (e.g., at state fairs and other major public events)
- Traveler surveys and interviews to gauge satisfaction with existing services and need for improvement

Needs Addressed:

- Provide Better Traveler Information
- Work on Public Outreach

Market Packages Incorporated:

- Not Applicable

Potential Impacts:

This project is intended to ***increase the utilization of traveler information*** on the part of the traveling public, through promotion and customer-input-based enhancements of traveler information delivery strategies. Increase utilization of traveler information will contribute to reductions in travel delay and associated reductions in fuel consumptions and emissions, and will contribute to reduced driver frustration and reduce the number of accidents.

Magnitude of Costs:

The cost of this project will vary widely depending on the number and intensity of the specific marketing strategies that are pursued. At a minimum, it is recommended that $75,000 be reserved to develop the regional Action Plan, and an additional $300,000 be reserved to support the highest priority strategies identified in the plan.

7.3 Public Transportation

7.3.1 Project 1: Enhance Transit Traveler Information with Real-Time Data

Description of the Concept:

This project will add real-time transit information, such as the estimated arrival time of a specific bus at a specific bus stop, to existing sources of METRO transit traveler information, such as through the METRO web site and Computerized Telephone Information System (CTIS). Concerns about the reliability of transit services, including the uncertainty of bus arrival times, has been identified as one of the reasons that people avoid transit, and even among existing transit riders, is a source of frustration. This project will make using transit more convenient, which, when coupled with overall high quality services, will promote use of transit.

Currently, METRO provides transit information via their web site and through two telephone services. Their automated transit information hotline (METROLine) provides pre-recorded information on published (e.g., “static”, or non-real-time) bus route and schedule information, and provides access to a live operator, who has access to the same static information. Their Personalized Bus Itinerary service allows users to develop customized transit itineraries through interaction with live operators, who enter information on origin and destination and travel times into a computer system that automatically identifies specific bus routes, stops and times.

This project represents a huge break-through in the quality and detail of transit information provided to the public. Real-time information on the current location of buses, and its status relative to its schedule (i.e., running early/late and by how much) will become available as part of METRO’s planned implementation of an Integrated Vehicle Operation Management System (IVOMS). In addition to providing transit dispatchers with the information they need to keep buses on schedule, to maintain proper headways and spacing, and to respond quickly to on-board emergencies, the system generates a constant stream of information of tremendous benefit to customers: the status of specific buses relative to arrival times at specific locations. This information can be expressed in terms of an actual estimated arrival time, or as is sometimes preferred, in a more generalized status message like “running a few minutes late.”

This project will integrate this real-time transit information into METRO’s existing traveler information services. Users will be able to access this information automatically from the existing web site and CTIS by entering in the route, stop and scheduled arrival time that they are interested in. Also, the live customer service operators who are available through the CTIS will also have access to this information. In the future, this information may also be made available through electronic displays at transit stops and stations, although that component is not included in this project, which focuses on integration of real-time status information into existing traveler information services.

The information provided through this project will allow transit users to fine-tune their own schedules and will eliminate much of the frustration associated with the uncertainty of transit vehicle arrival times, including the uncertainty of whether a bus has already passed a given stop. This information is especially useful during inclement weather.

The IVOMS to be implemented by METRO will include the capability to track the schedule status of each vehicle. This project will consist of formatting that information into a form suitable for dissemination to the public (e.g., converting raw schedule status information into a suitable traveler advisory) and integrating it onto the existing web site and CTIS.

Needs Addressed:

- Develop improved Public Transportation Management Strategies
- Provide access to real-time traveler information

Market Packages Incorporated:

- Transit Traveler Information
- Transit Vehicle Tracking

Potential Impacts:

This project will make using transit more ***convenient***, providing an improved service to existing transit users and will ***encourage ridership*** on the part of infrequent or non-transit-users by removing much of the uncertainty associated with transit. This uncertainty is typically one of the reasons cited by non-transit-riders for why they don't use transit.

Magnitude of Costs:

The major cost components of this project include: development of specific formats for real-time transit information (e.g., determining how this information will be provided to the public); implementation of the computer hardware and software necessary to convert the IVOMS vehicle schedule status information into that format and provide it to the traveler information systems; and redesign of the existing web site and phone systems to provide access to the real-time information. The cost of this effort is estimated at approximately $500,000.

7.4 Emergency Management

7.4.1 Project 1: Enhance Emergency Management Operations and Coordination

Description of the Concept:

This project supports enhancement of emergency management (EM) operations, including improving the coordination of EM operations among agencies.

Currently, an extensive emergency management system exists in the Houston region, including numerous agencies and facilities utilizing a wide range of advanced technologies and coordinating among themselves and other agencies to varying extents. For example, the Office of Emergency Management located at TranStar houses the Harris County Office of Emergency Management and City of Houston Emergency Management Division. These agencies normally operate more or less separately, focusing on their respective jurisdictions, but during an emergency situation work together with a host of other agencies via an event specific Emergency Operation Center, established at TranStar.

Despite many important accomplishments in enhancing emergency management operations and coordination through advanced technologies, there is much more that can and should be done, including implementation of many of the measures that have already been identified in agency EM plans. Despite great gains, gaps in coordination among agencies still exist, limiting the overall effectiveness of EM efforts in the region.

This project has two primary thrusts. First, the project will revisit current plans and relationships, modifying them as needed to reflect current structures and operational policies, and to promote mutual understanding of agencies capabilities and limitations. Second, the project will support efforts to develop systems that will allow EM agencies to talk, share data and operate more effectively.

Some of the specific activities that may be under-taken in this project include:

- Development or updating of EM plans
- Committee/task force efforts to develop/update agency operating agreements and procedures
- Implementation of new communications and computing infrastructure, including integration and coordination among agencies (e.g., implementation and integration of computer-aided dispatch and voice radio systems)

The first step in this project will be to gather existing EM plans and develop a regional list of action items. This will be accomplished through a planning effort guided by a multi-agency steering committee, and may include sub-committees or task forces. This project will provide funding to develop that action item list and to implement as many of the recommended actions as possible.

Needs Addressed:

- Enhance Emergency Management

Market Packages Incorporated:

- Emergency Response
- Emergency Routing

Potential Impacts:

The activities supported by this project will improve the ***effectiveness of emergency operations*** in the Houston region. Depending on the specific emergency in question, these improvements will provide various ***public safety benefits***, such as by speeding storm evacuations and reducing the number of accidents associated with the evacuations.

Magnitude of Costs:

The intent of this project is not to entirely fund all of the emergency management operations projects that are currently identified in various plans, or that may be identified as part of the development of the action item list to guide this project. Rather, this project recognizes that existing resources are not sufficient to accomplish as much in this area as is desirable, and provides a supplemental source of funding to support, not necessarily fully address, needs in this critical area. It is recommended that $1.5 million be budgeted to support this project.

7.5 Electronic Payment

7.5.1 Project 1: Regional Integrated Transportation Smart Card

Description of the Concept:

This project will implement a regional, integrated "smart card" for electronic payment of tolls, transit fares and parking. The card, a small electronic device to be used in lieu of cash, tokens, credit cards or other current electronic payment devices, will simplify transactions for travelers, providing them a single, convenient means to pay for a range of transportation services. By eliminating the hassle associated with maintaining separate payment cards for each system, or with carrying proper cash fares and payments, this project will make these transportation systems more convenient and thereby promote their utilization.

A primary focus of this project will be to establish a single payment instrument for the Harris County Toll Road Authority and METRO transit facilities and services. Currently, tolls may be paid using either cash, tokens or electronically, using an EZ Tag transponder mounted on the vehicle. Roadside devices read the EZ Tag when the vehicle passes and when the charges reach a predetermined level, bill the users electronic account. The various services provided by METRO utilize various combinations of cash, pre-purchased fare cards and monthly passes.

This project will develop a single payment system that will integrate the EZ Tag transponder and all other METRO transit service payment, and major parking facilities payment. The system may feature a single device that can be read by all of these systems and which can alternately be used from within a vehicle, such as for tolls and parking, or carried on one's person, for use on transit services. Alternatively, two different devices may be used, one for vehicle mounting and one for handheld use. Regardless of the number of variations in the physical device, the key to this project is the establishment of the institutional/financial linkages necessary to provide payment of a range of services through a user's single master regional transportation fees electronic account. These two aspects—the physical device and infrastructure needed to support their use, and the institutional/financial relationships and processes needed to support the regional integrated smart card—constitute the two major components of the regional smart card project.

This project consists of three phases. The first phase consists of developing a regional smart card integration plan. The plan will identify the specific transportation services to be included in the regional integrated smart card program, identify a specific plan for the financial and institutional structure needed to support the system, and develop a set of user requirements (including both institutional/agency and end user perspectives) to guide subsequent system design. Development of the plan should include participation by all of those organizations that may participate in the regional smart card program.

The second phase of the project will develop a detailed design and operations plan for the system. The design and operations plan will be based on the direction established in the regional smart card integration plan.

The third phase of the project will implement the system, including procurement, installation and testing of the physical infrastructure, and implementation of the financial/institutional structure needed to support the regional integrated smart card. Beyond the scope of this project, the system will require on-going operations and maintenance, including marketing of the card.

Needs Addressed:

- Expand the use of electronic payment
- Improve Toll Management

Market Packages Incorporated:

- Electronic Toll Collection
- Transit Passenger and Fare management

Potential Impacts:

This project will make it more ***convenient*** for travelers to utilize a variety of transportation facilities and services, including transit, which will promote increased transit utilization. Also, very large increases in efficiency associated with ***reduced cash handling costs*** will be possible.

Magnitude of Costs:

This project constitutes a very substantial endeavor, involving extensive planning and design efforts and a sizable investment in field devices and central processing equipment. It is recommended that a cost estimate for the system be developed as part of the preparation of the regional smart card integration plan. The estimated cost to produce that plan is $350,000. Depending on the specific system design, the cost to implement an integrated regional transportation smart card could exceed several million dollars.

7.6 Commercial Vehicle Operations

7.6.1 Project 1: HAZMAT Identification

Description of the Concept:

This project will implement an electronic system that will speed the identification of hazardous materials (HAZMAT) being transported on roadways in the Houston region. Identification of the specific type of cargo on board a vehicle that has been involved in a traffic incident, such as a spilled load or a collision, is critical to successfully responding to the incident. Incidents involving various types of HAZMAT typically can only be addressed by special HAZMAT response teams, and cannot be cleared by other emergency responders. Also, the specific type of HAZMAT dictates specific response protocols. By speeding the appropriate response to HAZMAT incidents, this project will reduce the public health, environmental, and traffic delay impacts of these incidents. The project will also enhance the safety of emergency responders.

There are several possible approaches to HAZMAT identification, including those that involve real-time vehicle location tracking and those that focus exclusively on on-board HAZMAT identifiers. In the case of those systems that feature on-board identifiers, the approach typically features one or more of the following three major components. The first component is a registry of HAZMAT shipments, associated with individual vehicles. The registry is an electronic database, with information supplied by HAZMAT shippers and vehicle operators. The second component is an identifier, mounted on board the HAZMAT transporting vehicle, such as a bar code, or a transponder or emitter of some sort. This device either includes a code linking the vehicle to the HAZMAT database, which in turn identifies the contents, shipper, etc., or the device itself contains this information (in which case the database may not be a component of the system). The third component is a reader device, installed along the roadside or carried by emergency response personnel, that is used to read the information on the on-board HAZMAT identifier, and in cases where the identifier does not contain the detailed information, retrieve the appropriate information from the electronic database.

In general, commercial vehicle operations (CVO) technology projects have been pursued primarily at the state and national level. This has been the case both because regulatory responsibility typically resides at these levels, and because, due to the interstate nature of the trucking business, effective CVO projects need to involve the trucking industry at the state and national scale. However, in that CVO projects like HAZMAT tracking directly involve local traffic and emergency management personnel, they are appropriately pursued in partnership between local, state and even national organizations. For these reasons, it is recommended that the further development of this project concept be done in cooperation with state and national governmental organizations who are taking the lead in CVO projects. In the case of the Houston region, the process should begin with a consultation with the state agency responsible for commercial vehicle regulation and enforcement.

Conceptually, this project includes three phases, a planning stage to involve a wide range of participants to identify an overall strategy, a design phase to develop a specific design for the system, and an implementation phase to implement the system.

Needs Addressed:

- Manage Hazardous Material Transportation

Market Packages Incorporated:

- HAZMAT Management

Potential Impacts:

This project will allow incident responders to ***quickly and accurately identify HAZMAT cargo*** that may have been involved in a traffic incident. This will improve the ***safety*** of incident responders and improve the effectiveness of the incident response, resulting in ***reduced public health, environmental and traffic delay impacts***.

Magnitude of Costs:

This project constitutes a very substantial endeavor, involving extensive planning and design efforts and a sizable investment in field devices and central processing equipment. It is recommended that a cost estimate for the system be developed as part of the initial planning effort. The estimated cost to conduct that effort is $350,000. Depending on the specific system design, the cost to implement an HAZMAT identification system could range from $500,000 to several million dollars.

7.7 Maintenance & Construction

7.7.1 <u>Project 1: Smart Work Zones</u>

Description of the Concept:

This project provides “smart work zone” equipment, consisting of portable traffic management equipment, that can be used to improve the safety and reduce traffic delays in roadway construction work zones. As is the case in most regions throughout the country, many freeway segments in the Houston region are of an age where maintenance, including reconstruction, is becoming more critical. When coupled with the high traffic volumes and speeds that characterize much of the Houston freeway system, maintenance and construction activities can create significant safety hazards for workers and drivers, and create significant delays. By providing portable versions of many of the same equipment that is used for freeway management, this project will improve safety and reduce traffic delays in and around construction work zones.

The tools available to manage traffic in works zones have advanced significantly in recent years. These tools include portable versions of most of the same technologies used for freeway management, including dynamic message signs, traffic detectors, surveillance cameras, highway advisory radio, lane control signals and, especially in the case of larger work zones, dedicated on-site incident management/motorist assistance patrols. In addition to these more standard technologies, there are a number of techniques specific to work zones that are available, including virtual rumble strips, and lane merge systems. Smart work zone systems may either be linked to, and controlled from the regional traffic management center (TranStar) or be controlled from temporary facilities in the field, a strategy most suited to larger, longer-term work zones. The same portable equipment used for construction work zone traffic management may also be utilized for special event and major incident traffic management.

Traffic management technologies used in work zones are applied in essentially the same manner as they are used in regular freeway traffic management. Messages are posted on the dynamic message signs regarding lane restrictions, delays, and in some cases even the total travel time or average speed through the work zone. Traffic detectors can play a special role in work zones by being used to monitor the speed of vehicles, which in turn can trigger vehicle-specific speed warnings, or if desired, trigger enforcement actions. In addition to the devices themselves, the smart work zone requires control software, which may be resident at a central location, or at an on-site command center.

This project will include two phases. The first phase consists of developing a smart work zone design concept report. The report will identify the specific smart work zone equipment, and possibly the specific technologies, to be utilized, along with concepts of operation for the smart work zone equipment sets. The concepts of operation will identify how the equipment will be used in various traffic control scenarios and will include procedures and diagrams illustrating prototypical set-up scenarios. The smart work zone design concept will also identify the number of the various pieces of equipment to be purchased. The second phase of this project consists of procuring the specific smart work zone equipment and installing any needed elements at TranStar or other remote control locations.

Needs Addressed:

- Improve work zone management

Market Packages Incorporated:

- Work zone management
- Work zone safety monitoring

Potential Impacts:

The deployment of smart work zones, which are essentially portable versions of the same type of equipment that is used for freeway traffic management, will generate the same sorts of benefits as those associated with the Houston region freeway management system. Use of smart work zones will ***reduce the number and severity of accidents*** in and around work zones by providing travelers with information that will make them more aware, and presumably more cautious. By helping to slow traffic, smart work zones will also ***improve the safety of work zone personnel*****.** Smart work zones will ***help maintain traffic flow*** through construction areas, thus ***reducing delay and associated fuel consumption and vehicle emissions*****.**

Magnitude of Costs:

The estimated cost to develop the smart work zone design concept is $40,000. The cost of each "set" of smart work zone equipment will vary depending on the number and type of devices included. For cost estimation purposes, it is assumed that a standard smart work zone package will include: 2 DMS, 1 HAR, 2 video traffic detectors, 1 CCTV camera and the power supply, controllers, communications equipment and computer hardware and software needed to operate the system. The estimated cost to procure two sets of smart work zone equipment is estimated at $600,000.

7.8 Planning/Other

7.8.1 Project 1: Enhance Agency-Agency Outreach, Coordination and Communication

Description of the Concept:

This project extends regional ITS coordination and outreach activities to cities, counties and other public agencies that have not been heavily involved to date. As the regional ITS program matures and continues to expand geographically it is important to expand the institutional coordination that is key to successful ITS planning, design, implementation and operation. This project provides direction and a dedicated budget to support expansion of current agency outreach and coordination.

This project will focus on expanding representation on existing regional ITS committees, and possibly creating subcommittees or other structures to insure that any specific needs of the new, smaller and/or suburban/rural member agencies are addressed. If participation in regional ITS coordination activities is not made meaningful to these new members, they will not participate.

The first step in this project is to develop a new, expanded regional ITS mailing list. It is very important that the right contact at each agency be identified; "shotgun" approaches of sending mailings or e-mail are not as effective as targeting communications to the person or people at each agency for whom regional ITS participation will be most meaningful. It is recommended that the development of the mailing list include individual phone calls to potential contacts, to be made by someone familiar with regional ITS and able to describe the benefits of participation—for some agencies, the ability to interest them during this initial contact will determine their participation.

Once the expanded mailing list is developed, a meeting should be held to introduce the potential new participants to the existing regional ITS program and coordination process. In addition to providing an overview of the current agencies and systems, this meeting should include presentation of specific information highlighting the benefits of participation for the new members, and an open discussion to determine the needs and expectations of the new members. Based on those needs and expectations, it may be desirable to modify or expand the existing regional ITS coordination program, such as by adding a subcommittee or task force focusing on unique needs or circumstances of the new membership.

Needs Addressed:

- Improve Agency Coordination

Market Packages Incorporated:

Not Applicable

Potential Impacts:

Experience has shown that in many cases the institutional issues associated with successful ITS projects are more challenging and more critical than the technological issues. Also, much of the success of ITS hinges on inter-agency coordination. By expanding existing regional ITS coordination and outreach activities to a broader membership, to include additional cities, counties and other agencies, this project will ***support the effective expansion of the regional ITS program***. Also, by providing a conduit for the lessons learned and collective, hard-earned ITS wisdom that has been gained through regional efforts to date, the activities of those agencies just beginning to become involved in ITS will be more effective.

Magnitude of Costs:

This project represents an incremental increase in the level of effort on the part of agency ITS staff and the personnel who support them in their regional ITS coordination activities, whether they be agency staff or consultant support. At the beginning of the project there will be a notable increase in existing labor requirements, in order to develop the contacts list of new members, contact them and preparing and conduct the initial meeting. Once the new membership has been included in regional activities, no significant increase over existing efforts is expected. If a consultant is retained to perform the initial effort, the cost of that effort is estimated at approximately $20,000.

7.9 ITS Deployment Phasing

The timing of project implementation will ultimately depend on the availability of funding and agency support. The high-level phasing plan presented here is based on the approximate relative priority and urgency of the needs addressed by the various projects (most needs were identified as high or medium priority), and on consideration of project inter-dependencies. Table 7-2 categorizes each project into one of three phases, reflecting the timing of their initiation: immediate (e.g., next two years), near-term (years 3 to 5), and long-term (year 6 and beyond). Not all projects will be completed within the time frame that they are initiated, including large, complicated projects, as well as on-going efforts, e.g., agency coordination.

Given that the strategic plan will be updated every few years and the uncertainty associated with future funding and technology developments, it is not meaningful to specify the specific timing of projects to be initiated beyond year 5. These projects will be given additional consideration during the next plan update.

7.10 Summary of Implementation Costs

Most of the descriptions of the recommended projects presented in Sections 7.1 – 7.8 include order-of-magnitude implementation cost estimates. Note that cost estimates have not been included for several projects for which the scope and scale of the effort have not yet been identified. Given the exclusion of these projects, the total amounts by time frame and for the entire program should be considered partial. The additional costs of the omitted projects could increase the total costs for each of the three time frames by several million dollars.

Also, additional costs might be incurred in the operation and maintenance phases of the ITS projects.

Table 7-2: High-Level Project Phasing Plan

Project	Recommended Phasing		
	Immediate (1-2 Yrs)	Near-Term (3-5 Yrs)	Long-Term (Yr 6+)
Traffic Management			
#1 – Expansion of Surveillance to Arterial Streets	■	■	■
#2 – Expansion of CCTV and Sensor Systems on Freeways and Critical Areas	■	■	■
#3 – Expansion of the RCTSS System	■	■	■
#4 – Arterial Street Traffic Detectors for the RCTSS	■	■	■
#5 – Expansion of Incident Management Off Freeways		■	■
#6 – Deploy and Integrate with Other Agencies Detecting Flood Conditions		■	■
#7 – Expansion of Air Quality and Emissions Monitoring		■	■
#8 – Establish Data Sharing Agreements and Formats	■	■	
#9 – Automate HOV Operations		■	
Traveler Information			
#1 – Deploy and Promote 511 Traveler Information System	■	■	
#2 – Marketing Effort for Traveler Information	■	■	■
Public Transportation			
#1 – Enhance Transit Traveler Information with Real-Time Data		■	
Emergency Management			
#1 – Enhance Emergency Management Operations and Coordination	■	■	
Electronic Payment			
#1 – Regional Integrated Transportation Smart Card		■	■
Commercial Vehicle Operations			
#1 – HAZMAT Identification		■	■
Maintenance and Construction			
#1 – Smart Work Zones	■	■	
Other			
#1 – Enhance Agency-Agency Outreach, Coordination/Communication	■	■	■

8.0 SUMMARY

The Houston Region has made great progress in implementing and operating intelligent transportation systems. Many systems have been successfully deployed, in many cases through a coordinated, multi-agency approach. These systems have provided significant benefits.

However, there are still unmet needs in the region. These needs can effectively be addressed through continued ITS investment, and, as importantly, through continued coordination and in some cases integration of ITS elements.

This strategic plan lays out the direction for continued planning, implementation and operation of ITS in the Houston Region. Together with the regional ITS system architecture, the plan identifies the framework for expanding the regional ITS, including enhancing services where they currently exist and continuing the geographic expansion of both ITS infrastructure and agency partnerships.

In order to remain useful, the strategic plan must be kept a living document, one that reflects changing conditions. For this reason it is recommended that the plan be updated every three years. It is recommended that HGAC oversee plan updates, under the direction of a committee of regional ITS agency stakeholders.